MONTHLY WEATHER REVIEW.

Editor: Prof. CLEVELAND ABBE.

VOL. XXIX. DECEMBER, 1901. No. 12

INTRODUCTION.

The MONTHLY WEATHER REVIEW for December, 1901, is based on reports from about 3,100 stations furnished by employees and voluntary observers, classified as follows: regular stations of the Weather Bureau, 159; West Indian service stations, 13; special river stations, 132; special rainfall stations, 48; voluntary observers of the Weather Bureau, 2,562; Army post hospital reports, 18; United States Life-Saving Service, 9; Southern Pacific Railway Company, 96; Hawaiian Government Survey, 200; Canadian Meteorological Service, 32; Jamaica Weather Office, 160; Mexican Telegraph Service, 20; Mexican voluntary stations, 7; Mexican Telegraph Company, 3; Costa Rican Service, 7. International simultaneous observations are received from a few stations and used, together with trustworthy newspaper extracts and special reports.

Special acknowledgment is made of the hearty cooperation of Prof. R. F. Stupart, Director of the Meteorological Service of the Dominion of Canada; Mr. Curtis J. Lyons, Meteorologist to the Hawaiian Government Survey, Honolulu; Señor Manuel E. Pastrana, Director of the Central Meteorological and Magnetic Observatory of Mexico; Camilo A. Gonzales, Director-General of Mexican Telegraphs; Mr. Maxwell Hall, Government Meteorologist, Kingston, Jamaica; Capt. S. I. Kimball, Superintendent of the United States Life-Saving Service; Lieut.-Commander W. H. H. Southerland, Hydrographer, United States Navy; H. Pittier, Director of the Physico-Geographic Institute, San Jose, Costa Rica; Capt. François S. Chaves, Director of the Meteorological Observatory, Ponta Delgada, St. Michaels, Azores, and W. M. Shaw, Esq., Secretary, Meteorological Office, London; Rev. Josef Algué, S. J., Director, Philippine Weather Service.

Attention is called to the fact that the clocks and self-registers at regular Weather Bureau stations are all set to seventy-fifth meridian or eastern standard time, which is exactly five hours behind Greenwich time; as far as practicable, only this standard of time is used in the text of the REVIEW, since all Weather Bureau observations are required to be taken and recorded by it. The standards used by the public in the United States and Canada and by the voluntary observers are believed to conform generally to the modern international system of standard meridians, one hour apart, beginning with Greenwich. The Hawaiian standard meridian is 157° 30′, or $10^h\ 30^m$ west of Greenwich. The Costa Rican standard of time is that of San Jose, $0^h\ 36^m\ 13^s$ slower than seventy-fifth meridian time, corresponding to $5^h\ 36^m$ west of Greenwich. Records of miscellaneous phenomena that are reported occasionally in other standards of time by voluntary observers or newspaper correspondents are sometimes corrected to agree with the eastern standard; otherwise, the local standard is mentioned.

Barometric pressures, whether "station pressures" or "sea-level pressures," are now always reduced to standard gravity, so that they express pressure in a standard system of absolute measures.

During the temporary absence of Professor Abbe, Mr. H. H. Kimball has been designated Acting Editor of the REVIEW.

FORECASTS AND WARNINGS.

By Prof. E. B. GARRIOTT, in charge of Forecast Division.

The first half of the month was marked by a succession of severe storms in the Atlantic coast districts. Storm warnings were hoisted along the coast well in advance of their approach, and all interests were fully advised regarding their dangerous character. On the morning of the 3d transatlantic shipping interests were advised that a severe storm would move northeastward off the middle Atlantic coast the night of the 3d. This storm passed well to the northward of the transatlantic steamship routes, and joined a deep depression that covered the north portion of the British Isles. By the morning of the 9th this depression showed barometric pressure 28.68 inches at Sumburgh Head, Scotland, with fresh to whole westerly gales over England, Ireland, and Scotland, after which the center moved eastward.

The severest storm of the month in the Lake region prevailed during the 13th and 14th. Warnings of the approach of this storm were issued for the upper Lake region the night of the 12th. On the 25th and 26th a severe storm prevailed on the north Pacific coast. Timely warning of the approach of this storm was issued to points on the Washington coast.

In the Lake region, the central valleys, and the Southern States the cold waves of the month were exceptionally severe. On the 8th and 9th an area of low barometer, which was attended by heavy rain and followed by a cold wave, moved northeastward over the west and middle Gulf States. This cold wave carried the line of freezing temperature to the Alabama and Mississippi coasts on the morning of the 10th. The following forecast, which covered the conditions of the succeeding two days, was made for Alabama and Mississippi the night of the 8th (Sunday):

> Rain Monday; much colder; Tuesday fair and cold. Temperature will fall to freezing or below to the coast line within the next thirty-six hours.

The Montgomery Advertiser, of December 10, 1901, remarked as follows regarding this warning:

> The cold wave warning was issued fully thirty-six hours in advance of the cold changes; it was telegraphed to all the important towns of the State, from which points it was distributed by mail; it is learned that the information was posted in over 1,500 places in the State yesterday morning, which demonstrates the very thorough and rapid system the Weather Bureau now has for getting such warnings before those who are actually interested.

During the second decade of the month a cold wave of remarkable persistency and exceptional severity covered practically the entire United States. This cold wave extended

over the Plateau and Pacific coast districts during the 12th, 13th, and 14th, carrying the line of freezing temperature to extreme southern Arizona and the interior of extreme southern California by the morning of the 14th. On the 11th special cold wave and snow warnings were sent to live stock and railroad interests in the Denver forcast district, and on the 12th warnings were issued of freezing temperature in Arizona. On the morning of the 12th fruit shippers and orange growers in California were warned of the approaching cold. In all districts east of the Rocky Mountains warnings were distributed twenty-four to forty-eight hours in advance of the cold wave.

The second cold wave of the month in the Southern States prevailed from the 14th to the 16th, and was closely followed by a third, which was the severest of the month over the Southeastern States. The following have been selected from press notices of this cold wave:

Pacific Rural Press, San Francisco, December 21, 1901:

There has been some injury in the citrus fruit and winter vegetable districts, but, thanks to the early warnings of the Weather Bureau, those who know how to burn and smoke as a preventive from frost effects saved much property and gave a new demonstration of the efficacy of the protective measures which have been brought to high development in California.

The New Orleans Times-Democrat, December 17, 1901, editorial:

The Weather Bureau gave ample notice of the coming of the cold wave, and its predictions have seldom been more accurate as to the extent of the wave, the territory that would be affected by it, and the degree of cold the thermometer would record; and this warning did much to prevent any serious damage to the cane crop from the freeze by giving the planters time to prepare for it.

Chattanooga News, December 21, 1901:

The United States Weather service has kept the country correctly informed on the weather during the past week. If we mistake not, predictions have been verified in every instance. There is no department of our Government that has shown more improvement in ten years than the weather service. We pay this compliment to the army of men who keep their eyes on the thermometers.

Pittsburg Post, December 16, 1901, editorial:

Much credit is due the Pittsburg station of the United States Weather Bureau for its truthful and timely predictions in the recent sudden changes of weather in this section. Warnings far in advance of the first local intimation of a cold snap were sent to shippers of perishable goods, and thus much damage was averted that otherwise would have resulted. When the continuous rains and heavy snows set in warnings were also sent out notifying property holders of the imminent danger of a flood.

Pittsburg Gazette, December 16, 1901:

The disaster to a large fleet of coal boats on the river last night is shown to be not chargeable to the weather service, which sent early warning of the coming of the high waters.

Proof has been given Pittsburg in the past few days of the efficiency of the United States Weather Bureau, and particularly of its Pittsburg office, which brings the Government service to our very doors. Warning was given of the approach of the cold wave so long in advance of its arrival that persons whose business is largely dependent on weather conditions were enabled to take the precautions required by a change of temperature. Similarly the persons affected by a rise or fall of the waters were warned of the flood that has been a remarkable accompaniment of this visitation of winter. The increasing usefulness of the United States Weather Bureau to a variety of business interests long since vindicated its right to a place among Government institutions. It serves the farmer, the man who deals in farm products, the shipper by rail, the shipper by river, and the men who go down to the sea in ships to take their chances against wind and waves, and it serves them well. It is in the hands of careful, pains-taking men, whose efforts to make their studies of meteorology serve the transportation, agricultural, and commercial interests are so successful that this branch of the Government is shown to be a good business investment.

On the 19th the following warning was given the widest possible distribution in Florida:

Center of low moving rapidly southwestward over Gulf. Minimum to-night in central and north Florida will equal last night and outlook is for lower temperature Friday night. All precautions against damage by cold justified for next two nights.

The warning was followed on the morning of the 20th by the following:

Temperature will fall to about 20° at Jacksonville to-night, with temperature below freezing in the interior as far south as Jupiter. Emergency warnings, and notify postmasters.

The official in charge of the Weather Bureau office at Jacksonville reports as follows, regarding the cold wave of the 20th and 21st, and the efforts that were made to warn various interests in the State of its approach:

The cold wave warnings of the 19th and 20th were of great benefit to fruit and vegetable growers north of the twenty-seventh parallel of latitude.

The telegram of the 19th was particularly timely and effective in influencing those interested to prepare for the severe weather anticipated. It was repeated immediately by this office to one hundred and thirty-three stations, and the information was widely disseminated by the Seaboard Air Line Railway from this city to Tampa. The efforts of the above company were made more effective by using the cold-wave warning, which is four long blasts from the locomotive. This whistle warning enables growers 5 or 6 miles from the railroad to receive warnings promptly, and with the same degree of certainty as those who have the benefits of telegraphic communication. This system was put into operation in Florida five years ago, and the railroads of the State quickly realized the importance of the warnings to farmers along their lines. Steamers plying along the St. Johns River, from Jacksonville to Sanford and Green Cove Springs, display the cold-wave flag with great advantage to the people on the river. Telephone lines recently extended from Western Union centers were also called into use.

The morning of the 20th dawned overcast and slightly warmer, the forecast indicating a cold wave for Jacksonville and Tampa. Soon after its receipt, a message from the Central Office indicated that the temperature in this city the following morning (21st) would be 20°, and that freezing conditions would occur in the interior as far south as Jupiter. The forecast was fully verified; the temperature in this city fell to 19.5°, and a slight skim of ice formed in the interior in the vicinity of Jupiter, with light frost in the Miami region. On the morning of the 20th, 143 telegrams were sent from this office, and all mediums for distributing warnings were utilized. In consequence more than a million dollars' worth of fruit, vegetables, and other property was protected, and the saving as a direct result of the warning amounted to $540,000.

A large number of letters have been received by the official in charge of the Weather Bureau office at Jacksonville with regard to the benefits that have been derived from the warnings above referred to.

During the second decade of the month destructive freshets occurred in the Appalachian Mountain districts. Excellent work was done by local observers of the Weather Bureau in notifying coal and river interests at the headwaters of the Ohio of the approach of the high water. The month closed with one of the most extensive floods on record in the James River Valley. Valuable service was rendered in connection with this flood by the official in charge of the Weather Bureau office at Richmond, who issued warnings throughout his district twelve to eighteen hours in advance of the flood stages.

The display of storm warnings on the lakes for the season of 1901 was discontinued as follows: on Lake Pepin, at the termination of December 4th; on Lakes Michigan, Huron, and St. Clair at the termination of December 14th; on Lakes Erie and Ontario at the termination of December 15th; on Lake Superior at the termination of December 11, 1901.

BOSTON FORECAST DISTRICT.

The month was stormy, with phenomenally heavy precipitation and sudden and abnormal ranges in temperature. The storm of the 14–15th was of unusual severity and caused much damage to property. The approach of this storm was duly announced in the forecasts and by the timely display of storm warnings along the coast. The Boston Post said, in its news columns: "But for the timely Weather Bureau warning much greater damage would have resulted." The Boston Globe said: "Shipping had ample warning from the Weather Bureau."—*J. W. Smith, Forecast Official.*

CHICAGO FORECAST DISTRICT.

A cold wave appeared in the extreme Northwest on the morning of the 12th, which gradually extended, with increasing intensity over the entire district. Its force was broken in the extreme Northwest on the 20th and over the eastern and central portions of the district on the 21st and 22d. For long duration and low temperature it was the most remarkable cold wave that has prevailed in the district so early in the winter season for twenty-five years. The shipment of perishable goods was at a standstill. Warnings were issued well in advance, almost without exception, throughout all portions of the forecast district, and the benefits derived from the information were undoubtedly very great. The most severe storm of the month on the upper lakes accompanied the approach of this cold wave during the 13th and 14th. Considering the severity of the storm, comparatively few wrecks were reported and it is thought that most of the vessels sought shelter as soon as the warnings were observed.

On the night of the 21st the car ferry *Muskegon* was wrecked in making the entrance to the harbor at Ludington, Mich., while high southwest wind was prevailing. Warnings for high winds had been sent to the west shore of the lake before the departure of the *Muskegon*, but car ferries of this character, as a rule, make trips across the lake in the most severe storms, and generally find no difficulty in making a passage in a storm of ordinary character, such as the one of the 21st and 22d.—*H. J. Cox, Professor.*

NEW ORLEANS FORECAST DISTRICT.

Severe weather conditions occurred over this district in December. Very well-marked cold waves crossed the district during the month, for which warnings were issued, as a rule, forty-eight hours in advance of the occurrence of verifying temperatures. Special temperature warnings were issued for the benefit of the sugar planters. The warnings were of great value.—*I. M. Cline, Forecast Official.*

DENVER FORECAST DISTRICT.

The month was characterized by mild weather. This temperature condition so favorable to live stock interests was interrupted, however, on the 11th and 12th, when a cold wave extended over the district. Special warnings of snow and cold weather were sent to live stock and railroad interests, and warnings of freezing temperature were telegraphed to points in Arizona. Live stock interests sustained no material loss.—*F. H. Brandenburg, Forecast Official.*

PORTLAND, OREG., FORECAST DISTRICT.

Two storms of great severity crossed the district during December. Both were successfully forecast, and warnings were sent to all seaports eight to twelve hours before the high winds began. Several lives were lost and many shipwrecks and other casualties occurred during the gales. The ship disasters were confined almost exclusively to the inward bound fleet, and, so far as known, no seagoing vessels left port after warnings were issued.—*Edward A. Beals, Forecast Official.*

HAVANA, CUBA, FORECAST DISTRICT.

On December 14 a warning of strong northwest winds and lower temperature was received from Washington and disseminated throughout the island; the forecast was amply verified. Conditions did not warrant the issue of warnings or advices at any other time during the month.—*W. B. Stockman, Forecast Official.*

AREAS OF HIGH AND LOW PRESSURE.

Movements of centers of areas of high and low pressure.

Number.	First observed.			Last observed.			Path.		Average velocities.	
	Date.	Lat. N.	Long. W.	Date.	Lat. N.	Long. W.	Length.	Duration.	Daily.	Hourly.
High areas.		°	°		°	°	*Miles.*	*Days.*	*Miles.*	*Miles.*
I	1, a. m.	53	108	2, a. m.	41	97	1,000	2.0	500	20.8
II	2, a. m.	50	100	7, p. m.	48	69	1,700	5.5	309	12.9
				8, p. m.	34	78	2,000	6.5	308	12.8
III	4, a. m.	37	123	5, a. m.	39	108	1,000	1.0	1,000	41.7
IV	6, a. m	35	121	14, a. m.	47	54	5,525	8.0	690	28.8
V	11, p. m.	51	120	17, p. m.	48	69	3,650	6.0	608	25.3
VI	15, a. m.	47	122	20, p. m.	46	78	4,300	5.5	782	32.6
VII	18, p m.	51	104	23, a. m.	32	65	3,925	4.5	872	36.3
VIII	25, a. m.	37	100	27, a. m.	46	60	3,200	2.0	1,600	66.7
IX	25, a. m.	43	123	28, p. m.	46	60	4,000	3.5	1,143	47.6
X	27, a. m.	43	123	30, a. m.	39	108	1,100	3.0	367	15.3
XI	30, a. m.	54	114	2, p. m.*	32	81	2,750	3.5	786	32.8
Sums							34,150	51.0	8,965	373.6
Mean of 12 paths							2,846		747	31.1
Mean of 51.0 days									670	27.9
Low areas.										
I	3, p. m.	48	125	5, a. m.	47	104	1,300	1.5	867	36.1
II	5, a. m.	43	123	7, a. m.	47	89	1,900	2.0	950	39.6
III	6, a. m.	33	115	9, a. m.	45	74	3,050	3.0	1,017	42.3
				10, a. m.	48	68	3,800	4.5	844	35.2
IV	7, p. m.	54	114	9, a. m.	46	96	1,050	1.5	700	29.2
V	11, a. m.	33	115	16, p. m.	46	60	3,850	5.5	700	29.2
	12, a m.	50	97				2,800	4.5	622	25.9
VI	21, a. m.	53	105	26, a. m.	47	54	3,000	5.0	600	25.0
VII	23, p. m.	44	104	25, a. m.	42	76	1,800	1.5	1,200	50.0
VIII	26, a. m.	47	89	27, p. m.	46	60	1,950	1.5	1,300	54.2
IX	27, p. m.	29	95	31, a. m.	47	54	2,600	3.5	743	31.0
Sums							27,100	34.0	9,543	397.7
Mean of 11 paths							2,464		867	36.2
Mean of 34.0 days									797	33.2

*January.

For graphic presentation of the movements of these highs and lows see Charts I and II.—*Geo. E. Hunt, Chief Clerk Forecast Division.*

RIVERS AND FLOODS.

The upper Mississippi River was frozen over from Hannibal, Mo., northward at the end of the month, the dates of closing varying from the 3d, at St. Paul, Minn., to the 17th, at Keokuk, Iowa. On the 14th the usual winter gorge formed at the Wabash bridge, Hannibal, Mo., and on the 16th the river was blocked for a single day at Grafton, Ill. At Chester, Ill., it was blocked from the 18th to the 26th, inclusive. On the latter date, the U. S. S. *King* broke the gorge. Back of the city of Cairo, Ill., the river froze on the 19th and did not open again until the 26th.

At the end of November, 1901, running ice had been observed as far south as Dubuque, Iowa. It first appeared at Davenport, Iowa, on the 9th of December, and by the 20th had reached Memphis, Tenn., where, from the 20th to the 23d, inclusive, it was present in such quantities as to seriously interfere with navigation. The ice reached Arkansas City, Ark,, in large quantities on the 23d, but none was reported at Greenville, Miss., the next station below.

The Red River of the North closed at Moorhead, Minn., on the 2d. In the Missouri River ice was first reported at Sioux City, Iowa, on the 5th, and navigation was closed on the 17th. At Omaha, Nebr., the river was first frozen over on the 13th.

Ice was first observed at Kansas City, Mo., on the 15th, and at Hermann, Mo., on the 14th. At the latter place the river was gorged on the 19th and remained so at the end of the month. In the Illinois River navigation was closed on the 16th on account of ice and extremely cold weather. From the 19th to the 27th the Allegheny River, in the vicinity of Pittsburg, Pa., brought down some ice, as did also the Monongahela on the 21st and 22d. On the Ohio River thin ice was first observed at Cairo, Ill., on the 16th, and above Cincinnati in larger quantities after the 18th. The Arkansas River, at Webbers Falls, Ind. T., was frozen over from the 15th to the 20th, inclusive, and at Little Rock, Ark., from the 19th to the 22d, the earliest closing on record at the latter place. The White River at Newport, Ark., was also closed by ice from the 20th to the 25th, inclusive. Floating ice was reported in the Red River at Arthur, Tex., on the 16th, 17th, and 18th.

In the Susquehanna River, at Harrisburg, Pa., light ice was running on the 20th, and in the West Branch, at Williamsport, Pa., on the 11th. The Potomac River was also full of running ice on the 20th, and floating ice was observed in the Pedee, Wateree, and Ocmulgee rivers on the 22d and 23d.

At the end of the month there were 17 inches of ice in the Mississippi River at St. Paul, 13 inches at Dubuque, and 6 inches at Hannibal. In the Red River of the North, at Moorhead, there were 17 inches; in the Missouri River at Bismarck, N. Dak., there were 12 inches, and at Omaha, 8.5 inches.

As was to be expected during a cold month with considerable ice, the stages of the Mississippi system north of the mouth of the Ohio were lower than during the preceding month. In the Ohio and tributaries, and the rivers of the Atlantic and east Gulf States, conditions were different, owing to the heavy rains about the middle and near the end of the month. There was a moderate flood in the Ohio, beginning in the tributaries, and at Pittsburg, on the 14th. The highest water reported on this rise was 39.5 feet at Cincinnati, and its crest passed Cairo on the 24th at 27.6 feet. No warnings were necessary except in the vicinity of Pittsburg, where the crest stage on the 16th, 25.8 feet, or 3.8 feet above the danger line, was sufficiently high to cause considerable trouble. The following report of this flood was prepared by Mr. Frank Ridgway, the Official in Charge of the Weather Bureau office at Pittsburg.

The weather map of the 14th instant indicated a disturbance over the South and Middle Atlantic States of the character that is almost invariably followed by heavy rainfalls throughout the Allegheny and Monongahela valleys, such rainfalls sometimes causing floods in this section. This storm proved to be no exception to the general rule, and owing to the fact that rain fell steadily in Pittsburg during the forenoon of the 14th, I directed all river observers to send me special river reports at 4 and 8 p. m. When the 4 p. m. reports arrived they showed an average rainfall of over 1.22 inches over both valleys since 8 a. m., and the specials at 8 p. m. showed an average rainfall of 1.55 inches since 8 a. m. About 8 p. m. the rain turned to snow, and I immediately began sending out preliminary advices to all interests affected by flood stages in this locality, that preparations should at once be made for a flood stage by Sunday evening, December, 15, in the three rivers at Pittsburg. I also had this information thoroughly advertised in the morning papers, as many persons would not be at their places of business on Sunday, and would therefore not receive personal notice. Through these notices and the newspaper warnings all interested parties were advised to keep in touch with this office during the day.

The regular Sunday morning river reports showed an average rainfall over both valleys of about 2 inches, ordinarily indicating a stage of 30 to 35 feet at Pittsburg by Sunday night or Monday morning; but, owing to the advance of the cold wave from the west which was already beginning to be felt, it was at once evident that the flow of water would be checked to some extent by the freezing up of the smaller tributaries of the Allegheny and Monongahela rivers, and that consequently a stage of more than 25 feet could not be expected.

The highest stage and most disastrous flood that ever visited Pittsburg occurred February 6, 1884, when a stage of 33.3 feet was reached.

As a definite supplement to the preliminary advices of Saturday night, at 9 a. m. Sunday the police departments of Allegheny and Pittsburg, were notified that a flood stage could positively be expected by Sunday night or early Monday morning, and immediately thereafter all river observers were telegraphed to furnish hourly special river reports until 4 p. m. Very few of the observers, however, did so for the reason that many of the telegraph offices were closed on that day, and the messages of instruction were therefore not delivered.

The Monongahela River, owing to its more southerly course, was putting out the most water during the day, the water at Pittsburg rising from 0.8 to 1.0 foot an hour until about 5 p. m. The Allegheny River rose from 0.6 to 0.9 foot an hour, and although it was believed that because of the low temperature the highest stage would be reached about midnight, yet it was surprising to note at 10 p. m. that the rivers were still rising at the rate of 0.5 foot an hour. All the various waiting interests were then notified that the highest stage would not exceed 26 feet. This completed the work of warning and the office was closed at 2 a. m. Monday.

The following are the maximum stages reached:

Monongahela River, 25.8 feet, at Pittsburg, 7:30 a. m., Monday, the 15th.

Allegheny River, at Herrs Island Dam, Twenty-second street, Pittsburg, 28.0 feet, at 5:30 a. m. same date.

Upper Ohio River, 24.3 feet, at Davis Island Dam, at 5 a. m. same date.

The warnings issued from this office enabled all business interests receiving them to transfer their movable property, stored in low cellars and warehouses, to places of safety, this movement alone no doubt involving property valued at millions of dollars. In addition, the river and coal operators were enabled to secure their craft and other vast interests in such a manner as to insure their preservation.

The stages in the tributaries of the Ohio on this rise, while decided, were not at all dangerous, and were well covered by timely warnings.

The heavy rains of the month also extended through the Atlantic States, and all the rivers speedily reached flood stages. The Susquehanna was from 4 to 10 feet above the danger line, with a maximum stage of 24 feet at Wilkesbarre, Pa., and of 21.4 feet at Harrisburg, Pa., the highest recorded stage for the month of December. Much damage resulted, particularly in the vicinity of Binghamton, N. Y., where the Chenango River rose to 20.4 feet, the highest stage since 1865, and materially assisted the work of overflow. The Lehigh and Delaware rivers rose far beyond ordinary flood lines, and an immense amount of damage and great delay were caused by overflows and washouts. The Hudson River was also at moderately high stage on the 15th, reaching at Albany, N. Y., 13.1 feet above the low water plane of 1876. Merchants were notified to remove property from cellars and low places, and no damage of consequence resulted.

Mr. E. R. Demain, the Official in Charge of the Weather Bureau office at Harrisburg, Pa., contributes the the following account of the Susquehanna flood within the State of Pennsylvania:

As regards the Susquehanna River system in general, and at Harrisburg, Pa., in particular, the flood of December 15, 16, and 17, 1901, was the most remarkable ever recorded in at least two particulars; the water reached the highest stage ever registered in December, and the rapidity of the rise was, perhaps, the greatest ever known.

Light rains fell at intervals on the 14th amounting to but 0.02 of an inch up to 2:30 p. m.; light rain began at 4:27 p. m., became heavy about 10 p. m. and continued till about 2:50 a. m. December 15; total amount of rainfall at Harrisburg, 1:20 inches. At midnight of the 14th the river registered 5.11 feet on the gage at the pumping station of the city water works, and at 2:30 p. m. of the 15th had risen to 13.9 feet. Reports of heavy rainfalls and high waters at Towanda and Lockhaven, Pa., which came early in the afternoon of the 15th, taken in connection with the swollen condition of the river at Harrisburg, indicated that a serious flood was iminent and at 2:30 p. m. the following warning was issued:

"The Susquehanna River has risen 8 feet at Harrisburg since midnight of the 14th; it was 13.9 feet at 2:30 p. m. to-day and rising about 10 inches an hour. The indications are that it will reach the danger line to-night and probably rise to 18 feet or above to-morrow."

At 6 p. m. the river observer at Wilkesbarre, Pa., reported the river at 24 feet, and the whole Wyoming Valley flooded.

The river at Harrisburg continued to rise rapidly; at 5 p. m. it registered 15 8 feet, and the danger line, 17 feet, was passed shortly before 7 p. m.; the highest point, 21.4 feet, was reached about 2 a. m. of the 16th, the river remaining stationary at that stage till about 6 a. m., when it began to recede slowly, but continued above the danger line till about noon of the 17th. By 8 a. m. of the 18th it had fallen to 14.2 feet.

It is difficult to account for the suddenness and magnitude of this extraordinary flood. Under ordinary circumstances the rainfalls reported would have caused a moderate flood of about 10 feet. The mild weather of the 13th to the 15th doubtless opened all the small tributaries which had been ice-bound, and caused the melting of all the snow within the basin of the Susquehanna, but so far as could be ascertained the quantity of snow was not great, and it is not believed these two factors combined would have carried the flood wave above 12 feet. The only explanation that can be offered for this sudden rise is that the rainfall over most of the Susquehanna watershed, more particularly that drained by the North Branch and especially on the main river within 50 or 60 miles above Harrisburg, must have been very much heavier than at Harrisburg or the stations from which telegraphic reports were received.

Considerable damage was done to property in south Harrisburg, Lochiel, and Steelton, Pa., the water submerging many streets, filling cellars, and in some cases covering the first floors of buildings. The fires in many industrial establishments were extinguished and operations in some were impeded to such an extent as to compel the managers to close them down. The floods caused no loss of life in this vicinity.

The greatest damage was perhaps done at Wilkesbarre, where the river is reported to have reached 24 feet, 10 feet above the danger line, 0.7 foot higher than on March 11, 1893, and the highest point registered since the flood of 1865. Mines were flooded and many houses on the lowlands suffered, in some cases the water reaching a point 4 feet above the first floor. Some of the occupants were removed during the night in boats, while many remained in their houses until morning. The concrete bridges erected during the past year at a cost of $60,000 for the purpose of providing a means of escape from the houses on the lowlands during times of high water were of no service, as the water covered them completely.

Reports of damage came from all points along the river and its principal tributaries, and the total loss of property was enormous. More damage appears to have been done on the North Branch than on the West Branch or on the Juniata River; at Williamsport, Pa., the highest stage reached was but 0.7 foot above the danger line, while at Lockhaven the maximum stage reported was only 7 feet

Two lives were reported lost in the flood on the North Branch in Luzerne County, one near Hazleton, Pa., and the other in Nanticoke, Pa.

Following are the greatest December floods on record at Harrisburg: December 12, 1878, 18.5 feet; December 29, 1881, 11 feet; December 19, 1888, 11.5 feet; December 16, 1901, 21.4 feet.

The Potomac River above Washington rose a few feet above the nominal danger line, but no damage was reported.

The rise in the James River was comparatively moderate, a stage of 0.8 foot above the danger line, 12 feet, being reached on the 17th. Local warnings were issued on the 16th, and, in consequence, all portable property liable to overflow at a 13.5 foot stage was removed to places of safety.

The upper portion of the Santee River system was at ordinary flood stage at the same time. The rise was forecast in due season and was without unusual feature.

The floods of the closing days of the month were much more pronounced, except in the extreme upper Ohio River, and were attended by much more serious consequences. They began in the tributaries of the Ohio River on the 29th, and the crest had not progressed very far beyond Wheeling, W. Va., on the 31st. New River was in flood for the fifth time during the year, an occurrence never before known. At Charleston, W. Va., the Great Kanawha River reached a stage of 38.5 feet on the 20th, or 8.5 feet above the danger line. Great damage was done; in fact, from all river valleys on both sides of the mountains came reports of unusually high water, washouts, wrecks, overflows, breaking of dams, flooding of manufactories, loss of livestock, etc. The total damage amounted to many millions of dollars, nearly all of which was absolutely unavoidable. Flood warnings were issued promptly and generally, and the loss of additional millions thereby prevented. The flood in the upper Tennessee River is thus described by Mr. L. M. Pindell, Official in Charge of the United States Weather Bureau office at Chattanooga, Tenn.

The river fell slowly after the 20th, becoming stationary by the 24th, when light rain fell over the system, continuing at intervals, until the 26th, saturating the ground and producing a slow rise in the river. On the morning of the 27th, an average of over two inches of rain had fallen over the headwaters during the previous twenty-four hours, producing a rise of 8 feet at Clinton, Tenn., 5 feet at Kingston, Tenn., 7 feet at Knoxville, Tenn., and nearly an 18-foot rise at Speers Ferry, Va., with the river one foot below the danger line. The following forecast was then issued: "The river and tributaries will rise rapidly. About a 17-foot stage will occur at Knoxville, Tenn., Saturday, and a 24-foot stage at Chattanooga, Tenn., Saturday night." At 8 a. m., Sunday the 29th, the stage at Chattanooga, Tenn., was 24 feet, and 17.2 feet at Knoxville, Tenn. The information as to Chattanooga's expected stage was telegraphed to the observer, Cairo, Ill. The following message was telephoned to Kingston, Tenn: "Clinch River rising rapidly at Clinton and Speers Ferry. Heavy rain above your station. The river will rise rapidly, reaching about 20 feet at your station, Saturday night." The stage at Kingston, Tenn., at 8 a. m., Sunday morning, was 18.6 feet. The morning river reports on the 29th disclosed additional heavy rains, averaging over 2½ inches over the system, between 8 a. m. of the 28th and 8 a. m. of the 29th, with rain still falling. As the river was already at a moderately high stage, this indicated a general rise attended with more or less danger to property. Flood warnings were issued at once. The following message was telephoned to Kingston, Tenn: "River 3½ feet above danger line at Clinton and rising. Heavy rain over entire headwaters. River will reach and probably pass danger line at your station Monday. Warn public."

The observer at Knoxville, Tenn., was notified that over two and one-half inches of rain had fallen above his station and that the river would rise rapidly. The observer at Cairo, Ill., was informed as to rainfall above, and that the river would pass the danger line at Chattanooga, Tenn., by noon Monday. Postmasters and various business interests at many places received the following flood warning: "Heavy rainfall above. River and tributaries rising rapidly. River will pass danger line at Chattanooga Monday. Warn public." The following summary was furnished the press: "The river will pass the danger line at Chattanooga, Tenn., by noon Monday. The crest can not be estimated at this time as rain was still falling over the entire system when the last reports were received. Flood warnings have been sent to Knoxville and Kingston, Tenn., and over the lower river as far as Cairo, Ill. The river will continue to rise Monday and Tuesday. As the ground is already full of water all the rainfall will find its way into the river channel and help to augment the tide." The 8 a. m. reports of December 30th, (Monday) gave almost 11 feet of rise at Charleston, Tenn., over 12 feet at Knoxville, Tenn., and 8 feet at Kingston, Tenn., and Chattanooga, Tenn., with the river above the danger line at every station above and within one foot of it at Chattanooga, Tenn. At 10 a. m. the Chattanooga stage was 32.7 feet; at 3 p. m. 34 feet, and at 6:40 p. m. 34.9 feet. The following forecast was made and extensively issued, the Associated Press assisting in its dissemination: "The river will continue to rise to-night and Tuesday, reaching a stage between 40 and 42 feet by midnight Tuesday."

The observer at Cairo, Ill., was also notified of the conditions over the system and the expected stage at Chattanooga. The 3 p. m. reports of the 30th showed a slight fall at Charleston, Tenn., and Speers Ferry, Va., and rises at all other points, and the following note was entered on the p. m. bulletins: "No change made in forecast issued this morning. The rise will be slow for the next thirty hours." The morning reports of the 31st showed a slight fall at Loudon, Tenn., stationary at Knoxville, Tenn., falling at Charleston and Speers Ferry and still rising at Kingston and Clinton, Tenn. The following forecast was issued: "The river will rise slowly till about noon of Wednesday; it will reach the 40-foot mark about 11 o'clock to-night, and the crest will be between 41 and 42 feet."

Special readings were made during the day as follows: 9 a. m., 37.7 feet; 10 a. m., 37.9 feet; 3 p. m., 38.6 feet; 5 p. m., 38.8 feet; 7 p. m., 39.0 feet; 8 p. m., 39.2 feet; 9 p. m., 39.3 feet; 10 p. m., 39.4 feet, and 11 p. m., 39.5 feet. The month closed with the river rising steadily and with the highest river on record for the month of December by 13 feet and over. Light drift began passing this station in the afternoon of the 27th, became moderately heavy in the afternoon of the 28th, and was heavy all day of the 29th, 30th, and 31st. It consisted of logs, fences, outhouses, haystacks, trees, and trash. The high tide over the headwaters affected the railroads, causing the Southern Railway to annul all trains between Knoxville, Tenn., and Asheville, N. C., the water covering the tracks between Newport and Rankin, Tenn. All the factories and mills under the 40-foot mark and merchants whose cellars were below the 40-foot mark had from 72 to 80 hours warning and took the necessary steps to remove their goods and protect their property. This action was not confined to this city alone, but extended over the entire river valley from Knoxville and Kingston to Cairo. The Nashville, Chattanooga, and St. Louis Railroad branch from Kingston, Tenn., to Rome, Ga., was abandoned on the 30th. Trains were all delayed and compelled to run slowly. Washouts were reported on the Southern Railway at White Pine, N. C. All familes, about seventy-five in number, who were below the 41-foot mark were notified to move, which they did before the water reached them; all above the 41-foot mark were instructed to remain. As far as known, not a dollar's worth of property between Knoxville, Tenn., and Cairo, Ill., was lost or damaged that could have been saved.

The flood in the lower Tennessee River from Florence, Ala., to its mouth continued until January 9, 1902, and was thus

reported by Mr. P. H. Smyth, Official in Charge of the United States Weather Bureau office at Cairo, Ill.:

The rise, which was due principally to heavy rainfalls over the upper watershed, set in at Florence, Ala., on the 26th, and reached Johnsonville, Tenn., on the 28th. It crested at Florence on January 6, 1902, at a stage of 21.0 feet, and at Johnsonville on January 9, at a stage of 28.5 feet.

Warnings were sent out well in advance of the flood's crest, and were disseminated by telegraph, telephone, and mail. They were the means of saving considerable property; stock was driven out of the bottoms to places of safety and large quantities of cross-ties on the islands and river banks were removed to high ground or otherwise secured.

This office has learned of no damage which a warning could have averted, and of no material damage resulting from the high stages.

The warnings were taken advantage of in other ways besides protecting property in danger. The head of a lumber firm located in a nearby town informs this office, that his firm got out about 150,000 feet of logs on the rise.

Mr. B. Bruce of Savannah, Tenn., in a communication to this office regarding the information furnished him, expresses himself as follows: "The information received from your office is of much importance to the general public in this section. I have telephone connection with all parts of this entire section, and keep all posted in regard to sudden rises in the rivers. The information received during this last rise was the means of saving a great deal of stock and other property. Few knew of its coming until I sent out notice."

The very accurate information telegraphed to this office by the official in charge of the Weather Bureau office at Chattanooga, Tenn., relative to existing and prospective conditions in the upper river was of much interest and value to persons in this section who have interests along the Tennessee River.

The flood in the James River Valley was one of the most extensive ever experienced in that section, the stages ranging from 3 feet above the danger line at Lynchburg to 11.2 feet above at Richmond. The crest stages were well forecast, and were very timely. Mr. E. A. Evans, the Official in Charge of the Weather Bureau office at Richmond, sends the following account:

One of the most extensive and threatening floods, in all its aspects, that has ever occurred in the James River Valley since records have been kept was a result of a period of precipitation beginning at 4 p. m. Saturday, December 28, and ending during the early morning of Monday the 30th. It was general over the whole watershed and the amounts deposited were heavy, particularly in the Appalachian and Blue Ridge portions of the basin, where they ranged from 2.50 to 4.28 inches. The effect of these conditions was emphasized by the preceding cold and wet condition of the ground, so that there was nothing to prevent a maximum run-off from reaching the drainage tributaries and the main stream. During Sunday forenoon, telegrams began coming in from the special river and rainfall stations; flood-warning messages were issued for upper river points and advisory warnings locally, as detailed in the latter part of this report.

As anticipated, the river began rising during Sunday night, and the next morning had reached 12.2 feet on the gage and was still rising. Throughout the day it rose steadily at the rate of about 0.4 foot an hour, and it early became evident that a serious flood was impending. In the early morning additional special telegrams were received from Lynchburg, Charlottsville, and Buenavista, Va. At Columbia, Va., the key to the local situation, the telegraph wires went down early in the forenoon. Prompt steps were taken, however, to advise local interests of the probable conditions that would occur during the afternoon and night.

By 11 a. m. the wharfs of the Virginia Navigation Company, the Clyde Line, and the Baltimore Steam Packet Company were under water, and in the early afternoon the fast rising tide had entered Lester street, cutting off street car communication between this city and the suburb of Fulton. The lower floors of houses in the neighborhood were flooded, and the residents driven up into the second stories. As night came on the flood had increased sufficiently to get into the lower business portions of the city, and Main street, near Seventeenth, soon became impassable, street car traffic was interrupted and all business houses in the vicinity were forced to close their doors.

The morning of Tuesday, December 31, found a section of the city, embracing a large number of retail stores and the butcher and huckster stands in the Old Market, under water varying in depth from 1 to 6 feet. At noon the official in charge went over the flooded area in a boat. The conditions really beggared description. Imagine a body of water about 900 feet wide, and deep enough to traverse in a boat, running directly through the business portion of the lower part of the city, and extending from the river proper inland about half a mile; and not only this, but the entire water front from one to three blocks back from the river, and extending from Fifteenth street to Fulton, or over a mile, covered with 4 to 8 feet of muddy water. Within this whole area not a wheel was turning in any manufacturing establishment, the shipyards were flooded and all lines of wholesale and retail business were completely paralyzed. A large quantity of lime stored in the plant of Warner, Moore & Co. began to slack as soon as reached by the flood, setting fire to the building. During the afternoon the waters continued to rise until about 4 p. m., when the gage read 23.2 feet, the highest since June, 1889, when 25 feet was had. At this point it remained practically stationary for an hour and then began to fall slowly. Long before this, however, the city gas plants had been flooded, the furnaces quenched and workmen driven out. The city was without gas Tuesday and Wednesday nights, and manufacturing establishments, newspaper plants, etc., using gas for fuel were crippled.

The nights of December 30-31 and January 1 will long be remembered by many of the citizens living in the vicinity of lower Fulton and Gillies Creek. In these suburbs the waters rose to such a height, and at one time so rapidly, that a number of families were forced to flee for their lives, and eventually several hundred were rendered temporarily homeless. A portion of the water front of the neighboring town of Manchester, on the opposite side of the river, also suffered in the same way, though not to so great an extent, about fifty families being reported as driven from their homes. As above noted the recession of the waters began about 5 p. m. of December 31, but it was not until the night of January 1 that the streets of the city in the flooded area again became clear of water and open to traffic.

Compared with preceding notable floods the present one is surpassed in respect to maximum stages reached by those occurring in the years 1870, 1877, 1886 (April), and 1889 (June), by from 1.1 to 5.4 feet; yet, when the magnitude of the interests jeopardized by it are considered, it may fairly be held to stand at the head of the list in importance.

The following shows the flood forecasts issued and the steps taken for their dissemination, together with the gage readings, regular and special, made:

By 1:30 p. m. Sunday, December 29, sufficient data was at hand to justify the issue of preliminary warnings locally. A stage of about 12 feet by 8 a. m., Monday was forecast. At 4 p. m. Sunday flood forecasts were wired to upper river points comprising Lynchburg, Norwood, and Scottsville, Va.

At 10 a. m. Monday the maximum height for the day, locally, was placed at 18 feet, and at noon a messenger was sent through the city district threatened to make a house to house distribution of the warning and advise the removal of goods. The telephone was also freely used in warning special industries and in sending out general information to public and press. At 11 p. m. Monday, in consequence of the general uneasiness induced by wild rumors afloat, it was deemed best to issue a statement that would be as positive, yet as conservative, as the case would allow, and accordingly the last forecast of the flood was made and distributed, viz:

"The maximum flood height will probably not exceed 24 feet, occurring to-morrow;" and on the following morning, Tuesday, by phone and note on weather map, "The maximum flood height will occur to-day and will probably not exceed 24 feet."

Gage readings taken were as follows:

December 30.—8 a. m., 12.2 feet; noon, 13.9 feet; 2 p. m., 14.5 feet; 3:15 p. m., 15.1 feet; 5 p. m., 15.9 feet; 11:30 p. m., 19.0 feet.

December 31.—3 a. m., 20.5 feet; 4 a. m., 21.0 feet; 8 a. m., 21.9 feet; noon, 22.5 feet; 1 p. m., 22.5 feet; 3 p. m., 22.9 feet; 4 p. m., 23.2 feet; 5 p. m., 23.0 feet; 10 p. m., 21.8 feet.

January 1.—8 a. m., 20.5 feet, and 11:30 a. m., 18.9 feet. This was the last of the special readings taken.

While the damage done by the flood was considerable, amounting to thousands of dollars, not including the losses experienced from the enforced suspension of business, yet it was for the most part unavoidable and was not in any way due to want of prompt and effective distribution of warnings or of time for proper preparation. In all cases the Bureau sent out warnings twelve to eighteen hours in advance of the arrival of the predicted conditions.

The North Carolina rivers did not rise much above the danger lines, and a warning of moderately high stages, only, was issued on the 30th.

More rain fell over South Carolina, and the rivers were proportionately higher. Warnings of dangerous stages over the Santee system were issued promptly, and were fully justified by subsequent events. The conditions prevailing at the time are thus described by Mr. L. N. Jesunofsky, Official in Charge of the Weather Bureau office at Charleston, S. C.:

Almost continuous rainfall at Gaffney, S. C., on the upper Broad River, and at Salisbury, N. C., on the upper Pedee River, from the 27th to the 31st, measuring 4.65 inches and 4.38 inches, respectively, effected a rise of 23.5 feet at Camden, S. C., 28.2 feet at Cheraw, S. C., and 20.3 feet at Columbia, S. C., during the 28th to 31st. The Wateree River at Camden, S. C., reached the danger line, 24 feet, at 8:30 a. m. of the 29th. The point of danger, 27 feet, at Cheraw, S. C., was reached at 5 a. m. of the 30th. The Congaree River at Columbia, S. C., reached the point of danger, 15 feet, at 1 p. m. of the 29th. At the end of the month the

waters at Camden, Cheraw, and Columbia, S. C., were 6.0 feet above danger points and rising at the rate of 3.0 feet a day. The freshets within the three last-mentioned streams were due to reach Smiths Mills, on the lower Pedee River, and St. Stephens, on the Santee River, on January 7, 1902, as forecast. Driftwood, including a large amount of cut timber, was running heavily on the Wateree, Pedee, Congaree, Saluda, and Broad rivers during the 29th, 30th, and 31st.

The heavy rains, which began in the upper drainage areas late on the 27th and continued with but few hours' intermission to the 31st, wrought considerable damage throughout the upper counties in South Carolina. The Reedy River, a branch of the Saluda River, near Greenville, S. C., was far out of its banks. Quite a number of bridges were washed away and the roads were almost impassable until January 1. Trains in that section were running far behind their scheduled time, and the roadbeds were considerably damaged. The Yadkin River, in North Carolina, an upper tributary of the Great Pedee River, was 30 feet above the common water level on the afternoon of the 30th. A part of the dam of the Anderson Water, Light, and Power Company, located at Portman Shoals, 10 miles west of Anderson, was washed away on the night of the 29th, entailing a loss of about $75,000. Several cotton mills were compelled to shut down on account of the loss of water power. It is thought by some that the numerous drifting logs and rafts were the chief cause of breaking the dam.

The flood in the Chattahooche River was rapid, extensive, and exceedingly destructive. It was forecast as well and accurately as was possible under existing conditions, and the warnings were especially timely near and below Westpoint, Ga. The report on this flood was prepared by Mr. J. B. Marbury, Official in Charge of the Weather Bureau office at Atlanta, Ga:

The abnormally heavy rains which fell over the upper portion of the drainage area of the Chattahoochee River during the last day or two of the month caused severe floods at nearly all points along its course. Up to the 28th low water prevailed. Rain began during the early morning of the 28th and continued with periods of excessive falls until the 29th. As a result the following abnormal rises occurred: Oakdale, Ga., 29th, gage reading 22.0 feet, a rise of 16.9 feet in 24 hours; 30th, 27.0 feet, rise of 5.0 feet in 24 hours; Westpoint, Ga., 29th, gage reading 19.0 feet, a rise in 24 hours of 12.2 feet; rainfall for preceding 24 hours, 7.30 inches; 30th, gage reading 25.0 feet, a rise of 6.0 feet. Eufaula, Ala.: the crest of the flood did not reach this point till the 31st as is shown by the following gage readings: December 28, 6.7 feet, a rise of 1.4 feet, due to moderate rains on the three preceding days; December 29, gage reading 11.7 feet, a rise of 5.0 feet; December 30, gage reading, 31.6 feet, a rise of 19.9 feet; December 31, gage reading, 41.0 feet, a rise of 9.4 feet.

Warnings sent from this office on the morning of the 29th to Westpoint and Columbus, Ga., Eufaula, Ala., and Bainbridge, Ga., stating that the danger line would be passed at each of these points, were fully verified, and were received in ample time to allow the saving of considerable property at points below Westpoint, Ga. The latter place was warned that the water would reach 25.0 feet during Monday morning, and as shown by the above figures the warning was fully verified. Columbus, Ga., was communicated with several times by telephone and the information given was of much value to the city.

At Westpoint, Ga., three persons were drowned and railroad communication was shut off for one or two days. Many damaging washouts were reported along the line of the Atlanta and Westpoint Railroad. Several bridges were washed away near that city and the business section of the city was under water for two days.

At Columbus, Ga., the water passed the danger line and part of the mammoth dam of the Columbus Power Company was swept away. Great piles of drift wood, trees, &c., landed against the highway bridge leading across to Alabama, and it was with great difficulty that the structure was saved. The power house of the Columbus Electric and Railroad Company was flooded and the town was in darkness. During the 31st the water at Columbus, Ga., receded several feet so that the electric and street railway plants were able to resume operations. No lives were lost, and no damages were reported from other points.

The rivers of southeastern Georgia were not abnormally high.

The floods over the Alabama system were also extensive, and equally well anticipated by Mr. F. P. Chaffee, the Official in Charge of the Weather Bureau office at Montgomery, Ala., Mr. Chaffee's record of the flood is as follows:

A heavy rainfall having been reported at Canton, Ga., on the morning of December 28, 1901, and the weather conditions being such as to presage further heavy rains over the watersheds of this river district, warnings were telegraphed to Rome, Ga., and Gadsden, Ala., advising that the upper Coosa River would rise rapidly; special reports were also called for from all river stations for the following morning (Sunday). The morning reports of the 29th showed the following 24-hour rainfalls:

Canton, Ga., 4.55; Resaca, Ga., 3.45; Rome, Ga., 3,64; Gadsden, Ala., 2.70; Wetumpka, Ala., 4.80; Tallassee, Ala., 7.59; Montgomery, Ala., 5.04; Selma, Ala., 3.10. At 10 a. m. warnings were telegraphed the different river stations that the following stages would be reached: Tallassee, Ala., 22 feet during night of 29th; Canton, Ga., and Resaca, Ga., moderate flood stages; Rome, Ga., 32, and Gadsden, Ala., 23 feet by night of 30th; Lincoln, Ala., 20 feet by morning of 31st; Wetumpka, Ala., 37 feet by night of 31st; Montgomery, Ala., about 34 feet by morning of January 1, and Selma, Ala., 35 or 36 feet by night of 1st or morning of 2d. Advice was also given that stock should be moved to high ground and other necessary flood precautions taken along the entire Coosa and Alabama rivers.

During the 30th special reports were called for from substations at 10 a. m., 12 noon, and 2 p. m., and in subsequent supplemental warnings the expected stages were raised to the following: Rome, Ga., 33 feet; Gadsden, Ala., 26; Lincoln, Ala., 22; Wetumpka, Ala., 49; Montgomery, Ala., 48; Selma, Ala., 50. Later, however, those interested were advised that the following stages would not be exceeded: Gadsden, Ala., 24 feet; Wetumpka and Montgomery, Ala., about 47, and Selma, Ala., about 47.5 feet.

During the entire rise the rivers were watched very closely, special reports being called for as needed and hourly readings of the river gage made at Montgomery, Ala., during a part of the time. Every effort was made to promptly notify those interested of the progress of the flood, and to relieve anxiety by definite information and warning. The absence of reports from Tallassee, Ala., on account of wire trouble, at the most critical period of the flood greatly hampered calculations on the stages in the lower Coosa and upper Alabama rivers, which were made even more difficult by the breaking of a large dam above Tallassee, Ala. However, the warnings were, on the whole, quite satisfactory, as was shown by the very commendatory press notices and by letters from persons in communities which were directly benefited. Considerable damage was done which no warning could avert, being mostly to mill property, public bridges, lumbering interests, and in the way of washouts of railroad embankments. On the strength of the warnings, several of the railroads centering here had repair trains in readiness to protect their roadbeds.

While it is difficult to approximate the value of the warnings, it is thought that about $200,000 worth of property was jeopardized by the high waters, the most of which was saved by the warnings. One of the most gratifying phases of the matter was the general confidence shown in the warnings, and the fact that the different interests affected by sudden river rises in this region appreciate the necessity for immediate protective measures when flood warnings are issued.

The flood crest passed Rome, Ga., during the morning of the 31st, Montgomery, Ala., about 6 p. m. of the 1st, and Selma, Ala., during afternoon of the 3d.

Recapitulation.—Total rainfall December 28–29th:

	Inches.
Canton, Ga	6.33
Resaca, Ga	3.50
Rome, Ga	3.81
Gadsden, Ala	2.82
Lincoln, (Lock 4), Ala	3.13
Tallassee, Ala	7.88
Wetumpka, Ala	4.90
Montgomery, Ala	5.10
Selma, Ala	3.10

Stations.	River stages.				
	Danger line.	8, a. m., 28th.	Total rise.	Highest reached.	Stage forecast.
	Feet.	*Feet.*	*Feet.*	*Feet.*	
Canton, Ga	20	3.6	17.4	21.0	Moderate flood.
Resaca, Ga	25	10.2	16.6	26.8	About 26 feet.
Rome, Ga	30	6.0	26.6	32.6	About 33 feet.
Gadsden, Ala	18	7.5	16.1	23.6	About 26 feet.
Tallassee, Ala	28	1.1	19.5	20.6	About 22 feet.
Wetumpka, Ala	45	8.7	37.8	46.5	About 47 feet.
Montgomery, Ala	35	5.5	41.3	46.8	About 47 feet.
Selma, Ala	35	6.0	41.0	47.0	About 47.5 feet.

The danger line was exceeded by several feet in the Black Warrior and lower Tombigbee rivers. Warnings were issued as usual, and no reports of serious damage have been received.

The rivers of the Pacific coast were higher as a rule, but nothing of special interest was noted.

CLIMATE AND CROP SERVICE.

By JAMES BERRY, Chief of Climate and Crop Service Division.

The following summaries relating to the general weather and crop conditions are furnished by the directors of the respective sections of the Climate and Crop Service of the Weather Bureau.

[Temperature is expressed in degrees Fahrenheit and precipitation in inches and hundredths.]

Alabama.—The mean temperature was 41.8°, or 4.6° below normal; the highest was 78°, at Citronelle on the 25th, and the lowest, zero, at Florence on the 15th and at Riverton on the 16th. The average precipitation was 7.80, or 3.48 above normal; the greatest monthly amount, 12.77, occurred at Tallassee, and the least, 2.69, at Thomasville.

Nearly all fall sown oats were killed by the severe cold of the second decade; excessive rains during 28–29th washed uplands badly, and caused damaging floods in all the large rivers.—*F. P. Chaffee.*

Arizona.—The mean temperature was 46.9°, or 1.7° below normal; the highest was 92°, at Parker on the 6th, and the lowest, 9° below zero, at Fort Defiance on the 13th. The average precipitation was 0.10, or 0.89 below normal; the greatest monthly amount, 1.80, occurred at Fort Apache, while none fell at a great number of stations.

The longest sustained cold weather of which there is any record at this station, obtained from the 13th to the 17th, inclusive, and citrus fruit trees in Salt River Valley were damaged to a considerable extent. Winter plowing and seeding are retarded on account of the dryness of the soil and the great scarcity of water for irrigation.—*Wm. G. Burns.*

Arkansas.—The mean temperature was 38.5°, or 3.9° below normal; the highest was 87°, at Bee Branch on the 24th, and the lowest, 6° below zero, at Mossville on the 15th. The average precipitation was 4.42, or 0.73 above normal; the greatest monthly amount, 6.26, occurred at Amity, and the least, 0.99, at Silver Springs.

The condition of wheat varies in the different sections of the State. Some correspondents report that the crop was damaged by the severe cold weather from the 14th to the 20th; others state that the crop was uninjured. As there was little or no snow to protect the crop, it is believed that some injury has resulted.—*Edward B. Richards.*

California.—The mean temperature was 47.4°, or 1.1° above normal; the highest was 90°, at Elsinore on the 18th, and the lowest, 5° below zero, at Bodie on the 13th. The average precipitation was 1.45, or 2.63 below normal; the greatest monthly amount, 9.50, occurred at Crescent City, while none fell at thirty-one stations.

The temperature was above normal and the rainfall considerably below the average in all parts of the State. Severe frosts occurred during the month, damaging oranges, young citrus trees, and vegetables, but causing no injury to early grain. Toward the close of the month dry northerly winds absorbed much of the moisture in the soil, and a severe "Santa Ana" on the 27th caused considerable damage to oranges in southern California.—*Alexander G. McAdie.*

Colorado.—The mean temperature was 27.8°, or 1.5° above normal; the highest was 81°, at Trinidad on the 23d, and the lowest, 31° below zero, at Wagon Wheel Gap on the 13th and at Fort Collins on the 14th. The average precipitation was 0.86, or practically normal; the greatest monthly amount, 3.06, occurred at Gilman, and the least, trace, at Perry Park.

The past three months have been characterized by a light snowfall in the mountain districts, and in general the amount on the ground at the close of December was much below normal. As a whole, the snowfall has been about equal to that for one and two years past; on the eastern slope it has been less, while on the western watersheds it has been 50 per cent greater. There were few snowstorms during October and November; in December, however, fully as much snow fell as during October and November combined. The prevailing high winds have swept exposed localities bare and the bulk is now in the gulches, the timber, and other places favorable to its conservation. The ground being dry, a large portion will be absorbed as it melts.—*F. H. Brandenburg.*

Cuba.—The mean temperature was 72.0°; the highest was 95°, at Central Rosario (Aguacate) on the 27th, and the lowest, 43°, at Central Rosario (Aguacate) on the 19th. The average precipitation was 1.57; the greatest monthly amount, 6.39, occurred at Central Santa Lucia (Gibara), and the least, 0.15, at Plantation Romelie (Guantanamo).

The precipitation was very unevenly distributed; in north-central Santiago de Cuba it was heavy, ranging as high as 6.39 inches; it was also moderately heavy in southeast Matanzas and northeast Santa Clara, where the monthly fall exceeded 3 inches; the areas where the fall was lightest are comprised of Pinar del Rio and Havana provinces, eastern Puerto Principe and western Santiago de Cuba, and the Guantanamo district of Santiago de Cuba. Cool weather continued throughout December, and an unseasonably low monthly mean temperature was a marked feature of the month. The tobacco crop made good progress in localities of central and western Pinar del Rio, in western Havana, and in northeast Santa Clara; elsewhere the continued insufficient rainfall has proved very injurious to the crop. In most districts there was not sufficient rain for young canes, but the comparatively dry weather was very propitious for preparations for grinding; a large number of sugar mills were operating on the last of the month. Small crops, as a rule, are in a fair condition.—*William B. Stockman.*

Florida.—The mean temperature was 56.1°, or 3.1° below normal; the highest was 89°, at Nocatee on the 14th, and the lowest, 12°, at De Funiak Springs on the 21st. The average precipitation was 2.60, or about normal; the greatest monthly amount, 5.17, occurred at Key West, and the least, 0.65, at Rockwell.

The month was unseasonably cold, with decidedly low temperatures during the second decade and on the first day of the third. The cold wave of the 21st proved rather disastrous to vegetables, where unprotected, as far south as the central district. Ill effects were also observed on the foliage of citrus trees over the same section. Pineapples were generally protected in central counties and escaped injury. Cold wave warnings were timely and of marked benefit to fruit and vegetable growers.—*A. J. Mitchell.*

Georgia.—The mean temperature was 43.7°, or 3.7° below normal; the highest was 80°, at Waverly and Waycross on the 13th, and the lowest, 3°, at Diamond on the 18th and 21st and at Greenbush on the 22d. The average precipitation was 5.78, or 2.14 above normal; the greatest monthly amount, 13.35, occurred at Clayton, and the least, 1.02, at Savannah.

The coldest and wettest December during the past eleven years. The cold spell, extending from the 15th to the 22d, was severe for the season, and gave the lowest temperature readings of the year. The rainfall was very heavy in the northern section of the State, the amount exceeding 10 inches at all stations. A marked deficiency in precipitation occurred in the southeastern counties, where the total monthly falls were less than 2 inches. The snowfall for the month was considerable. Winter wheat and oats suffered from the cold weather.—*J. B. Marbury.*

Idaho.—The mean temperature was 28.7°, or 2.2° above normal; the highest was 64°, at Lewiston on the 23d, and the lowest, 20° below zero, at Forney on the 12th. The average precipitation was 1.93, or 0.17 above normal; the greatest monthly amount, 5.22, occurred at Murray, and the least, 0.46, at Downey.

The month was remarkable for light snowfalls. All the low mountains are bare, cattle and horses grazing up to their summits and finding the grass sufficient to keep them in unusually good winter condition. The sheep ranges are free from snow and the grass has been so good that feeding has been unnecessary.—*S. M. Blandford.*

Illinois.—The mean temperature was 25.9°, or 4.5° below normal; the highest was 68°, at Griggsville on the 1st and 2d and at Mattoon on the 2d, and the lowest, 19° below zero, at Coatsburg on the 20th. The average precipitation was 2.77, or 0.59 above normal; the greatest monthly amount, 5.70, occurred at Albion, and the least, 0.35, at Zion.

Moderate temperatures prevailed early in the month, but on the 13th a cold wave began to be felt in the northwestern portion, and by the morning of the 14th had spread over the entire State. This cold wave was preceded by good rains throughout the greater portion of the State, and as the weather grew colder the rain changed to snow, affording a moderately good covering for wheat during the period of severe cold. There was, therefore, but little damage to wheat in the northern and central districts, and the crop is now in promising condition. In the southern district the condition is less favorable. Fruit appears to have been damaged in some localities by the severe cold.—*M. E. Blystone.*

Indiana.—The mean temperature was 26.9, or 5.1° below normal; the highest was 67°, at Bedford on the 1st and at Jefferson and Madison on the 13th, and the lowest, 19° below zero, at Marengo and Winamac on the 15th. The average precipitation was 3.93, or 1.24 above normal; the greatest monthly amount, 5.85, occurred at Vincennes, and the least, 1.57, at Auburn.

The ground continued too dry for wheat during the first week of December and the crop looked unpromising, but rains on the 8th and 9th improved its condition somewhat. On the 13th heavy rain, turning to snow, was general throughout the State; and, notwithstanding a cold wave of great severity which prevailed from the 14th to 22d, when the snow disappeared the fields looked green, showing that the plant had been well protected and was in better condition than at the inception of the cold wave. Frequent freezing and thawing during the last week of December were to some extent injurious to winter crops, but at the close of the month, wheat, rye, and clover were looking fairly well.—*W. T. Blythe.*

Iowa.—The mean temperature was 20.5°, or 3.1° below normal; the highest was 64°, at Indianola on the 1st, and the lowest, 31° below zero, at Le Mars on the 15th. The average precipitation was 0.93, or 0.45 below normal; the greatest monthly amount, 2.75, occurred at Belknap, and the least, 0.05, at New Hampton.

The weather conditions were generally favorable for feeding stock and farm operations usual to the season. During the period of extreme cold there was a sufficient amount of snow to protect fall wheat, rye, and the grasses. More than the usual amount of ice was put up during the month.—*John R. Sage.*

Kansas.—The mean temperature was 30.6°, or 3.2° below normal; the highest was 79°, at Pratt on the 31st, and the lowest, 17° below zero, at Achilles on the 14th. The average precipitation was 0.64, or 0.25 below normal; the greatest monthly amount, 2.46, occurred at Columbus, and the least, a trace, at Concordia, Medicine Lodge, Osborne, and Phillipsburg.

Weather very favorable for outdoor work. Wheat has generally continued in good condition; during the cold spell much of it had a light covering of snow, which, while not sufficient to prevent frosting of the blades, protected the roots; some fall sown alfalfa was cut to the ground. At the close of the month wheat was needing more moisture. Feed is abundant and cattle are doing well, though a scarcity of stock water is now being felt. Plowing was resumed in Montgomery County on the 26th.—*T. B. Jennings.*

Kentucky.—The mean temperature was 32.3°, or 5.1° below normal; the highest was 72°, at Warfield on the 14th, and the lowest, 22° below zero, at Fords Ferry on the 15th and 18th. The average precipitation was 4.90, or 1.36 above normal the greatest monthly amount, 7.79, occurred at Williamsburg, and the least, 1.56, at Carrollton.

The month was very cold with extremely low temperature during the third week. Wheat was protected by snow in most localities during the most severe weather and was not seriously injured, but it is small and thin and does not look very promising. Fruit trees were apparently not injured by the cold weather. Handling and marketing of tobacco progressed well. Stock was generally in fair condition, but considerable loss due to the eating of frozen, smutty cornstalks is reported.—*H. B. Hersey.*

Louisiana.—The mean temperature was 48.8°, or 3.7° below normal; the highest was 85°, at Lake Providence on the 24th, and the lowest, 9°, at Lake Providence on the 20th. The average precipitation was 6.19, or 1.58 above normal; the greatest monthly amount, 11.83, occurred at Clinton, and the least, 2.45, at Plain Dealing.

Cotton picking was completed in most parishes during November and was generally finished in the others during the first half of this month. The yield was generally below the average. The sugar cane crop was in excellent condition at the opening of the month and the weather was very favorable prior to the 15th. A severe cold wave then brought the temperature below 25° over the sugar region. Timely warnings had been issued, and as a consequence the bulk of the cane crop had been windrowed. Where not windrowed it was a total loss, and in the windrow was damaged to some extent. The remnants of the rice crop were thrashed in good condition. The corn crop was all housed during the month. Truck gardens were generally killed to the coast line by the freeze. Rye and oats are doing well.—*I. M. Cline.*

Maryland and Delaware.—The mean temperature was 32.7°, or 2.6° below normal; the highest was 74°, at Chestertown, Md., on the 14th, and the lowest, 15° below zero, at Sunnyside, Md., on the 22d. The average precipitation was 6.74, or 4.04 above normal; the greatest monthly amount, 11.18, occurred at Bachmans Valley, Md., and the least, 4.15, at Pocomoke, Md.

Winter wheat improved slightly during the month, but at its close was still far below an average condition. This was especially true of the late sown wheat; the early wheat was better in appearance, having fair stands and a good color. The rains were generally helpful, although some damage was done in the lowlands by excess of moisture. The lack of snow protection was seriously felt, despite the fact that periods of freezing and thawing were not frequent.—*Oliver L. Fassig.*

Michigan.—The mean temperature was 22.3°, or 3.5° below normal; the highest was 62°, at Grape on the 1st, and the lowest, 28° below zero, at Humboldt on the 21st. The average precipitation was 2.48, or 0.46 above normal; the greatest monthly amount, 5.95, occurred at Lathrop, and the least, 0.20, at Humboldt.

At the close of the month winter wheat looked generally strong and healthy, but it had rather a small top, little or no growth having been made since the close of November. It has been generally well protected with a snow blanket during and since the severe cold wave of the 14th to 22d. Although there is some complaint of hessian fly much less of this pest is reported than during the two preceding years, which is probably due to the fact that winter wheat was generally sown later this year than usual.—*C. F. Schneider.*

Minnesota.—The mean temperature was 13.0°, or 3.4° below normal; the highest was 57°, at Currie on the 1st, and the lowest, 48° below zero, at Detroit City on the 14th. The average precipitation was 0.57, or 0.13 below normal; the greatest monthly amount, 1.36, occurred at Moorhead, and the least, 0.10, at Pipestone.

From the 13th to the 20th the temperatures were very low, the minimums, occurring at most points on the 14th, being lower than any previously recorded during December in the history of the Weather Bureau stations in the State. The precipitation was all snow. At a few of the northern and central stations there was an excess of precipitation, but in the southern half of the State it was less than the normal. Snow covered the State during the entire month, except for the first few days in the southern portion.—*T. S. Outram.*

Mississippi.—The mean temperature was 43.3°, or 5.5° below normal; the highest was 78°, at Natchez on the 8th and 12th, Stonington on the 13th, and Leakesville on the 24th, and the lowest, zero, at Holly Springs and Ripley on the 15th. The average precipitation was 7.18, or 3.11 above normal; the greatest monthly amount, 11.70, occurred at Fayette, and the least, 3.26, at Holly Springs.

The mean temperature for the month was the lowest on record for December. From the 14th to the 21st, inclusive, the temperature ranged near or below freezing over the entire State. A snowfall, averaging about two inches, occurred in the northern tier of counties on the 14th.—*W. S. Belden.*

Missouri.—The mean temperature was 28.4°, or 5.1° below normal, the lowest December mean recorded since 1886; the highest was 71°, at Halfway on the 2d, and the lowest, 29° below zero, at Bethany on the 20th. The average precipitation was 2.93, or 0.67 above normal; the greatest monthly amount, 6.72, occurred at New Madrid, and the least, 1.02, at Appleton City.

From the 13th to 21st the weather was extremely cold, but winter wheat was well protected by snow and suffered little or no injury, except in some of the extreme southern counties where the snowfall was light and some damage was done by freezing. The crop was generally reported in good condition at the close of the month. The unusually cold weather was very severe on unsheltered stock, and there was some loss of young cattle and hogs. Many chickens were also frozen.—*A. E. Hackett.*

Montana.—The mean temperature was 23.0°, or 1.0°, above normal; the highest was 65°, at Livingston on the 1st, and the lowest, 31° below zero, at Glendive on the 13th. The average precipitation was 1.48, or 0.59 above normal; the greatest monthly amount, 3.45, occurred at Marysville, and the least, 0.29, at Culbertson.

In the west and central portions the weather during the month has been remarkable on account of its mildness. Over the central portion the precipitation was above the normal, the snow storm of the 5th and 6th being more severe in that section than in any other. A cold period was general over the central and east portions from the 12th to the 15th. High winds during the latter portion of the month drifted the snow and cleared the ranges and stock was enabled to get plenty of feed.—*E. J. Glass.*

Nebraska.—The mean temperature was 25.0°, or 1.0° below normal; the highest was 70°, at Alliance on the 5th, McCook on the 23d, and Madrid on the 30th, and the lowest, 38° below zero, at Hay Springs on the 14th. The average precipitation was 0.60, or 0.07 below normal; the greatest monthly amount, 2.04, occurred at Tekamah, and the least, a trace, at Edgar.

The precipitation was deficient in the winter wheat belt, but the crop has not suffered from the lack of moisture. Some think that the unusually cold weather about the middle of December may have injured wheat, but the general opinion is that the crop is in good condition at the end of the month.—*G. A. Loveland.*

Nevada.—The mean temperature was 32.5°, or 2.7° above normal; the highest was 78° at Sodaville on the 26th, and the lowest, 19° below zero at Wood on the 27th. The average precipitation was 0.69, or 0.85 below normal; the greatest monthly amount, 3.97, occurred at Lewers Ranch, and the least, trace, at Candelaria, Hot Springs, and Palmetto.

The month was milder and drier than usual. The first twelve days were moderately stormy, with good rains in the valleys and light falls of snow on the mountains. The weather was remarkably fine and clear from the 13th until the end of the month. Some plowing was done the early part of the month. The weather conditions were very favorable to stock interests.—*J. H. Smith.*

New England.—The mean temperature was 26.9°, or 0.8° below normal; the highest was 67°, at Middletown, Conn., on the 14th, and the lowest, 26° below zero, at Flagstaff, Me., on the 12th. The average precipitation was 7.59, or 4.08 above normal; the greatest monthly amount, 12.60, occurred at Hawleyville, Conn., and the least, 2.20, at Bemis, Me.

The weather of the month was very unfavorable for all outdoor work. Precipitation, largely in the form of rain, occurred on fifteen days, and the total at Boston, 8.49 inches, exceeds all previous December records at that station, the largest heretofore being 6.76 inches, in 1878. Excepting the excessive precipitation, the weather was characteristic of the first winter month.—*J. W. Smith.*

New Jersey.—The mean temperature was 32.6°, or 1.7° below normal; the highest was 68°, at Beverly on the 14th, and the lowest, 12° below zero, at Toms River on the 22d. The average precipitation was 7.30, or 3.91 above normal; the greatest monthly amount, 9.45, occurred at Charlotteburg, and the least, 4.87, at Cape May.

The snowfall for the month was light, except at stations in the upper part of the southern section, where from 6 to 9 inches fell on the 17th. In the north and northwest sections the ground was well covered during the last week of the month. Very little obstructive frost remained in the ground at the close of the month, owing to the excessive rains of December 27–30th.—*Laura M. Dey.*

New Merico.—The mean temperature was 36.3°, or 1.9° above normal; the highest was 85°, at Carlsbad on the 6th, and the lowest, 12° below zero, at Aztec on the 13th. The average precipitation was 0.16,

or 0.45 below normal; the greatest monthly amount, 1.70, occurred at Cloudcroft, 8,650 feet altitude, while none fell at many stations of the lower Rio Grande country.

Very pleasant winter weather, but the deficiency of precipitation is already causing some loss and much trouble to stockmen. There is scarcely a trace of snow about the headwaters of streams, which condition is already causing apprehension in regard to the spring water supply.—*R. M. Hardinge.*

New York.—The mean temperature was 26.0°, or 1.6° below normal; the highest was 75°, at Richmondville on the 14th, and the lowest, 23° below zero, at South Kortright on the 6th. The average precipitation was 5.05, or 2.24 above normal; the greatest monthly amount, 10.39, occurred at Cutchogue, and the least, 1.50, at Plattsburg.

The precipitation was the heaviest since official records began; winter wheat and rye backward, owing to late seeding, but were well protected by snow and were in good condition December 31. Month cold, with much snow. Disastrous floods on the 15th, washing out hundreds of railroad bridges and greatly damaging farm property in hilly sections.—*R. G. Allen.*

North Carolina.—The mean temperature was 39.8°, or 2.7° below normal; the highest was 83°, at Goldsboro on the 29th, and the lowest, 9° below zero, at Lenoir on the 20th. The average precipitation was 6.65, or 2.91 above normal; the greatest monthly amount, 13.95, occurred at Highlands, and the least, 3.52, at Selma.

The month was not favorable for the growth of winter grains. In the absence of snow covering the severe freeze from the 15th to the 22d, during which the temperature fell to below zero at eight western stations, caused much damage to winter wheat and oats; in addition much late seeded grain failed to germinate, resulting in poor stands and a generally unfavorable outlook.—*C. F. von Herrmann.*

North Dakota.—The mean temperature was 12.4°, or 0.3° below normal: the highest was 61°, at Valley City on the 23d, and the lowest, 43° below zero, at Dunseith on the 13th. The average precipitation was 0.74, or 0.35 above normal; the greatest monthly amount, 1.45, occurred at Medora, and the least, 0.08, at Cando.

The weather was generally favorable for stock on the ranges, the snow covering the ground not being heavy enough to prevent grazing, so that but little hay was fed.—*B. H. Bronson.*

Ohio.—The mean temperature was 27.9°, or 4.5° below normal; the highest was 73°, at Waverly on the 13th, and the lowest, 19° below zero, at Bladensburg on the 21st. The average precipitation was 3 79, or 1.17 above normal; the greatest monthly amount, 5.73, occurred at Wauseon, and the least, 2.42, at Greenville.

There was an excess of precipitation over most of the State and in many sections it was the coldest December on record. A very marked fall in temperature occurred on the 14th and 15th, the thermometer falling from 65° to 75° in 30 to 36 hours. A snowstorm on the 14th gave a good covering for the wheat in most sections of the State, and little damage was done during the succeeding cold weather. Wheat, in general, is more promising than at the last of November, the exception being in a few southeast counties. Corn is mostly cribbed. Meadows are in fair condition, but the reports on winter rye are rather unfavorable. It is feared that considerable injury has been done to peaches, especially in central and eastern counties. The cold spell gave a good crop of ice and much was gathered.—*J. Warren Smith.*

Oklahoma and Indian Territories.—The mean temperature was 38.4°, or 1.4° below normal; the highest was 81°, at Ryan on the 24th, and the lowest, 15° below zero, at Kenton on the 14th. The average precipitation was 1.12, or 0.76 below normal; the greatest monthly amount, 2.75, occurred at South McAlester, while none fell at Beaver.

Month was deficient in both temperature and precipitation. The greater portion of the precipitation occurred in advance of the cold period of the month, and falling mostly in the form of snow over the wheat belt of the section afforded fair protection to the cereals in the ground. The minimum temperatures reported, zero or below, were the lowest on record for the month of December. Reports received indicate but slight damage to fruit, stock, or to the cereals in the ground, from the low temperatures experienced. Wheat is generally in bad condition over the southern portion of Indian Territory and western Oklahoma, due generally to continued drought and to overfeeding of stock; over the remainder of the section the plant mostly looks brown and short, but is green close to the ground, and with sufficient moisture would probably develop.—*Charles M. Strong.*

Oregon.—The mean temperature was 39.2°, or 1.2° above normal; the highest was 78°, at Williams on the 3d, and the lowest, 6° below zero, at Pine on the 12th. The average precipitation was 4.99, or 1.74 below normal; the greatest monthly amount, 19.02, occurred at Glenora, and the least, 1.11, at Umatilla.

The month was favorable for the growth and development of grains and grasses, except in a few scattered sections of Jackson and Sherman counties, where the cold frosty weather retarded upward growth to a slight extent. Fall sown wheat made a remarkably vigorous growth, and that cereal is everywhere reported to be in an excellent condition. Fall rye and oats are also reported thrifty and promising.—*Edward A. Beals.*

Pennsylvania.—The mean temperature was 29.1°, or 2.7° below normal; the highest was 77°, at Lycippus on the 14th, and the lowest, 18° below zero, at Hawthorn on the 19th. The average precipitation was 5.91, or 3 04 above normal; the greatest monthly amount, 10.26, occurred at Mauch Chunk, and the least, 2.62, at Beaver Dam.

The weather conditions, particularly in the central and eastern portions of the State, were generally unfavorable for winter grain. The snow covering afforded insufficient protection, and the severe storms during the middle and latter part of the month caused heavy washouts and floods, which were damaging to grain, bridges, roads, and other interests.—*T. F. Townsend.*

Porto Rico.—The mean temperature was 75.8°, or about normal; the highest was 97°, at Hacienda Coloso on the 30th, and the lowest, 54°, at Adjuntas on the 16th. The average precipitation was 6.00, or 2.00 above normal; the greatest monthly amount, 13.03, occurred at Hacienda Perla, and the least, 1.17, at Santa Isabel.

During the last three weeks of the month crops in the northern and eastern portions of the island were injured and farm work interrupted by continuous rains; otherwise generally favorable conditions prevailed. Conditions were unfavorable for the maturing of cane, and as a consequence the density of the juice is low and the grinding delayed longer than expected. The crop promises to be an average one or above. Preparations for a new tobacco crop have been actively prosecuted, though curtailed to some extent by a limited supply of seed. The gathering of oranges has been quite general throughout the month, and the yield is highly satisfactory. The remnants of the coffee and rice crops were gathered during the early part of the month; both crops were good. There was a general scarcity of vegetables, minor fruits, and ground provisions. Pasturage unusually good for the season.—*E. C. Thompson.*

South Carolina.—The mean temperature was 44.0°, or 2.2° below normal: the highest was 80°, at Blackville on the 25th, and the lowest, 2°, at Liberty on the 21st. The average precipitation was 5.01, or 1.91 above normal; the greatest monthly amount, 10.23, occurred at Spartanburg, and the least, 1.28, at Gillisonville.

The month was unfavorable for agricultural interests, and the soil conditions did not permit much wheat sowing, while the temperature was too low for germination and growth. Oats were injured by the cold weather from the 15th to the 22d, especially on sandy soils. Cotton picking was completed. Floods occurred in all the "up country" streams on the 30-31st.—*J. W. Bauer.*

South Dakota.—The mean temperature was 18.7, or 3.0° below normal; the highest was 68°, at Bad Nation on the 1st, and the lowest, 42° below zero, at Oelrichs on the 13th. The average precipitation was 0.58, or 0.15 above normal; the greatest monthly amount, 1.45, occurred at Alexandria, and the least, 0.09, at Canton.

The prominent features of the month's weather were abnormally low temperature during the second decade, followed by abnormally high temperature during the third decade, and much cloudiness without corresponding amount of precipitation. Except during the cold weather of the second decade, and a snowstorm over the southwestern counties on the 16th, with high northerly wind and low temperature, which caused some herds on the ranges to drift considerably, the conditions were unusually favorable for the uninterrupted grazing of live stock and resultant economy of garnered stock feed; at the close of the month live stock was generally in good condition, with the range mostly free of snow.—*S. W. Glenn.*

Tennessee.—The mean temperature was 35.5°, or 4.3° below normal; the highest was 71°, at Springdale on the 13th, and the lowest, 18° below zero, at Rugby on the 21st. The average precipitation was 6.76, or 2.68 above normal; the greatest monthly amount, 12.63, occurred at Decatur, and the least, 3.10, at Peryear.

Winter grains made but little growth during the month; the excessive cold of the second decade greatly injured wheat, much of which was sown late and had not sufficient root to withstand the freeze; but the snow covering during this time was considerable protection in most sections, and the rains and milder weather following materially improved conditions.—*H. C. Bate.*

Texas.—The mean temperature was 48.1°, or 2.4° below normal; the highest was 92°, at Burnet on the 24th, and the lowest, 2° below zero, at Mount Blanco on the 14th and 15th. The average precipitation was 1.05, or 1.03 below normal; the greatest monthly amount, 7.29, occurred at Beaumont, while none fell at Fort Brown, Camp Eagle Pass, Fort Clark, Fort McIntosh, Fort Stockton, Fort Ringgold, Kopperl, Menardsville, and Sanderson.

Frequent and decided weather changes during the month had a damaging effect on all crops. The dry weather, alternate freezing and thawing, and an absence of snow covering, have injured wheat and oats to a considerable extent, and at the close of the month these crops were in a very unfavorable condition. The severe drought continued over the southwestern and west-central sections, and rain was badly needed over other portions of the State. Cutting and grinding cane were actively carried on throughout the greater portion of the month. Considerable damage was done to uncut cane by the severe freeze of the 14th and 15th, and on these dates all early vegetables were either killed or badly injured.—*Edward H. Bowie.*

Utah.—The mean temperature was 29.0°, or 2.2° above normal; the highest was 71°, at St. George on the 6th, and the lowest, 18° below zero, at Loa on the 12th. The average precipitation was 0.81, or 0.07

below normal; the greatest monthly amount, 2.20, occurred at Park City, while none fell at Emery, Green River, and St. George.

Very little farm work was done during the month. Fall grain continues in fair condition. The precipitation west of the Wasatch Mountains was heavy enough to greatly improve conditions on the ranges, but east of these mountains the rainfall was too light to effect any change.—*L. H. Murdoch.*

Virginia.—The mean temperature was 35.7°, or 4.0° below normal; the highest was 75°, at Ashland on the 2d, and the lowest, 14° below zero, at Burkes Garden on the 21st. The average precipitation was 6.45, or 3.66 above normal; the greatest monthly amount, 9.79, occurred at Bigstone Gap, and the least, 2.85, at Birdsnest.

Progress of crops was much retarded by the adverse weather prevailing. The temperatures obtaining were generally below normal, and this, combined with a want of snow protection, was disastrous, especially to late seeded winter wheat, oats, and clover. The early seeded, though injured to some extent, had, as a rule, sufficient root growth to enable it to withstand the worst effects of the freezing weather.—*Edward A. Evans.*

Washington.—The mean temperature was 37.0°, or 0.7° above normal; the highest was 66°, at East Sound on the 5th, and the lowest, 2°, at Northport on the 12th. The average precipitation was 3.81, or 1.84 below normal; the greatest monthly amount, 16.03, occurred at Clearwater, and the least, 0.23, at Ritzville.

Weather mild and open and favorable for growth of winter wheat, although the ground was without snow covering. Early sown wheat is in good condition; that sown in dry soil, during dry weather of October, came up poorly and unevenly, much of it failing to germinate until the rains of November; consequently it is weakly and not in fit condition to withstand severe freezes in the absence of snow covering. With continued open weather it is likely to improve and eventually become strong and vigorous.—*G. N. Salisbury.*

West Virginia.—The mean temperature was 32.3°, or 3.0° below normal; the highest was 75°, at Myra on the 13th, and the lowest, 9° below zero, at Central Station on the 16th. The average precipitation was 5.84, or 2.81 above normal; the greatest monthly amount, 8.97, occurred at Elkhorn, and the least, 3.57, at Parkersburg.

The weather during the month was very unfavorable for winter wheat, rye, and oats. The seasonable weather of the first part of the month was followed during the third week by severe cold. While wheat was fairly well protected by a good covering of snow it is feared that considerable damage was done. At the close of the month it was generally in very poor condition, and the outlook was not promising. Practically no farm work was done, and some corn yet remained to be husked.—*E. C. Vose.*

Wisconsin.—The mean temperature was 17.7°, or 4.3° below normal; the highest was 57°, at Racine on the 1st, and the lowest, 40° below zero, at Barron on the 13th. The average precipitation was 0.95, or 0.64 below normal; the greatest monthly amount, 2.28, occurred at Osceola, and the least, 0.25, at Antigo.

The most notable feature was the cold wave that overspread the State on the 13th and continued until the 21st. The ground was generally well covered with snow during this period and winter crops escaped injury.—*W. M. Wilson.*

Wyoming.—The mean temperature was 23.4°, or 0.5° below normal; the highest was 75°, at Fort Laramie on the 2d, and the lowest, 41° below zero, at Fort Laramie on the 14th. The average precipitation was 1.34, or 0.63 above normal; the greatest monthly amount, 3.28, occurred at Red Bank, and the least, 0.21, at Laramie.

During the severe storm of the 10th to the 17th several flocks of sheep were scattered in the southern portion of the State and some perished, but the losses were comparatively light. The month, as a whole, was favorable to stock, and practically no losses occurred among the cattle of the State. The heavy snows of the first half of the month provided a good stock of snow in the mountains, and coming early in the season much of it will be conserved for the water supply of next summer.—*W. S. Palmer.*

SPECIAL CONTRIBUTIONS.

EVAPORATION UNDERGROUND.

By EDWIN SWIFT BALCH.

In the MONTHLY WEATHER REVIEW for August and November, 1901, Mr. H. H. Kimball published two valuable papers giving the results of his observations in several *glacières* (or ice caves) in the Appalachians, and also touching at some length on subterranean meteorology. In the National Geographic Magazine for Decemher, 1901, is a note by Mr. W J McGee, referring briefly to underground evaporation. A few additional remarks, suggested by these articles, may be of use.

Subterranean meteorology is anything but a new subject, and it has already received a good deal of sporadic attention. As far back, at least, as 1796, Horace Bénedict de Saussure examined a number of cold current caves (breathing caves, blowing caves, or wind holes) in the Alps and the Apennines, and suggested a simple explanation of some of their phenomena. G. F. Parrot, in 1815, also studied the matter carefully. It is probably correct to say that all the scientists who have worked at the phenomena of *glacières* at some length, have examined also more or less into subterranean meteorology, for the reason that the formation of underground ice and the movements of air in caves are an inseparable matter. Among these observers may be mentioned Thury, who, in 1861, divided caves into static and dynamic caves; Browne, in 1865, and in the last twenty-five years, Schwalbe, Martel, and especially Fugger, who devoted fifty pages to "blowing holes" in his book, Ice Caves and Windholes (Eishöhlen und Windröhren, Salzburg, 1891–1893); the latter is the most important work about *glacières* yet published in German.

Many writers also have recorded their opinions about the possible refrigerating effects of evaporation underground. Among those in the affirmative may be mentioned Pictet, 1822; Scrope, 1827; Reich, 1834; Pleischl, 1841; Murchison, 1845; Olmstead, 1856; Hitchcock, 1861; White, 1870; Kirchhoff, 1876; Krauss, 1895.

In order to get a basis for future observations it may be well to try to formulate the present status of our knowledge of the action of evaporation as a possible factor in the formation of subterranean ice. There seem to be three most noteworthy points:

1. We know positively, from the observations of many good observers, that in many cases subterranean ice is due to the cold of winter.

2. We know almost surely, principally from the observations of Monsieur Martel, that in some cases evaporation lowers the temperatures in caves some 2° to 3° C.

3. We have absolutely no *proof*—only opinions as yet—that evaporation ever produces ice below ground.

The writer's own belief is that in all cases the cold of winter alone is the primary cause of subterranean ice, and that evaporation is practically of no importance in its formation. Our knowledge, however, of the exact effects of evaporation underground is still too limited, and the fact, moreover, that a certain number of scientists have held and that others probably now hold, that evaporation in some cases produces underground ice, emphasizes the need of further observation and experiment.

This problem, of course, can be solved in time. Much patient observation will be necessary, and it may be well to suggest that every observer will probably get more valuable data if he can observe in a certain number of places, rather than in one or two only; at least the writer's experience is that visits to many *glacières* and wind holes is beneficial, by broadening individual knowledge of the subject.

There is another method which may be suggested as a possible help, and that would be to make some experiments in laboratories. So far, de Saussure alone appears to have done anything of the kind. He passed a current of air through a glass tube filled with moistened stones, and found that this air current lost several degrees of heat in its passage. It would seem as though experiments in the same direction ought to afford some useful data.

Although this note is intended to touch on only one point of subterranean meteorology, yet it may be worth adding that the subject is a big one, and that many advances have been made in it in the last few years. It is only recently, for instance, that it has been recognized that the temperature of caves is not always the same throughout. There are many other such points which need elucidation, and the interest shown by the Weather Bureau is a welcome help to speleologists, and warrants the hope that further systematic observations and experiments will be made and more attention now be given to everything connected with the atmosphere underground.

FACILITIES FOR SYSTEMATIC STUDY OF CORRESPONDING WEATHER TYPES.[1]

By F. H. BRANDENBURG, Forecast Official, Denver, Colo.

During the summer of 1900, it was my privilege to spend a short time in the Forecast Division of the Central Office, and in making practise forecasts for the whole United States I often felt the need of "type maps," similar to the current map, available for reference. It is needless to say that in searching for these much time was consumed without satisfactory results, and this caused me to consider seriously the matter of devising some method of classifying maps according to type. Consultation with Professor Garriott encouraged me to undertake the work, and on my return to station, plans were formulated for a system of ready reference to all weather types shown by the morning maps issued by the Central Office during the past ten years.

My purpose in bringing this subject to your attention is not to lay down any procedure for study but merely to describe facilities which it is believed will prove a valuable aid in quickly refreshing the memory as to the different conditions and types that obtain during any particular month.

The size of the original maps precludes their use, and a small base map of the United States was therefore drawn and printed on half sheets of letter paper, as shown in fig. 1, a space being reserved on the left for notations. This space is divided into two columns, at the top of which the words "high" and "low," respectively, are printed on one set, while on the other set the words of the heading are reversed. As regards the lines to be reproduced, a sketch of the principal isobars, with the regions of high and low pressure suitably marked, was considered sufficient. The period covered being about ten years, thirty-six or thirty-seven hundred maps were sketched. These sketches were duplicated by means of carbon paper, the number of duplicates for each date depending upon the number of highs and lows on the map that were considered valuable in the classification. In some instances one map was sufficient for the set of high areas and one for the set of low areas, but occasionally as many as eight in all were necessary; in general four sufficed. The next step was to outline on each small map the shaded or rainfall areas shown on the Washington map of the succeeding day. By shading these areas with a green pencil we avoid interfering with the isobars, which are drawn in red. Thunderstorms are indicated by a small green cross, and the regions visited by temperature changes of 20° are outlined in black. Mention has been made of two columns on each sheet at the left of the map. In the appropriate column an entry is made showing the location of the high and the low areas. Each of the different entries is given first place on some one map, and the distribution of the maps is made in accordance with this entry. Every map thus made finds a place in some one of the ten or eleven districts adopted. For example, let us take the high areas for January. A map for each date on which such an area occupied the British Northwest Territory will be found

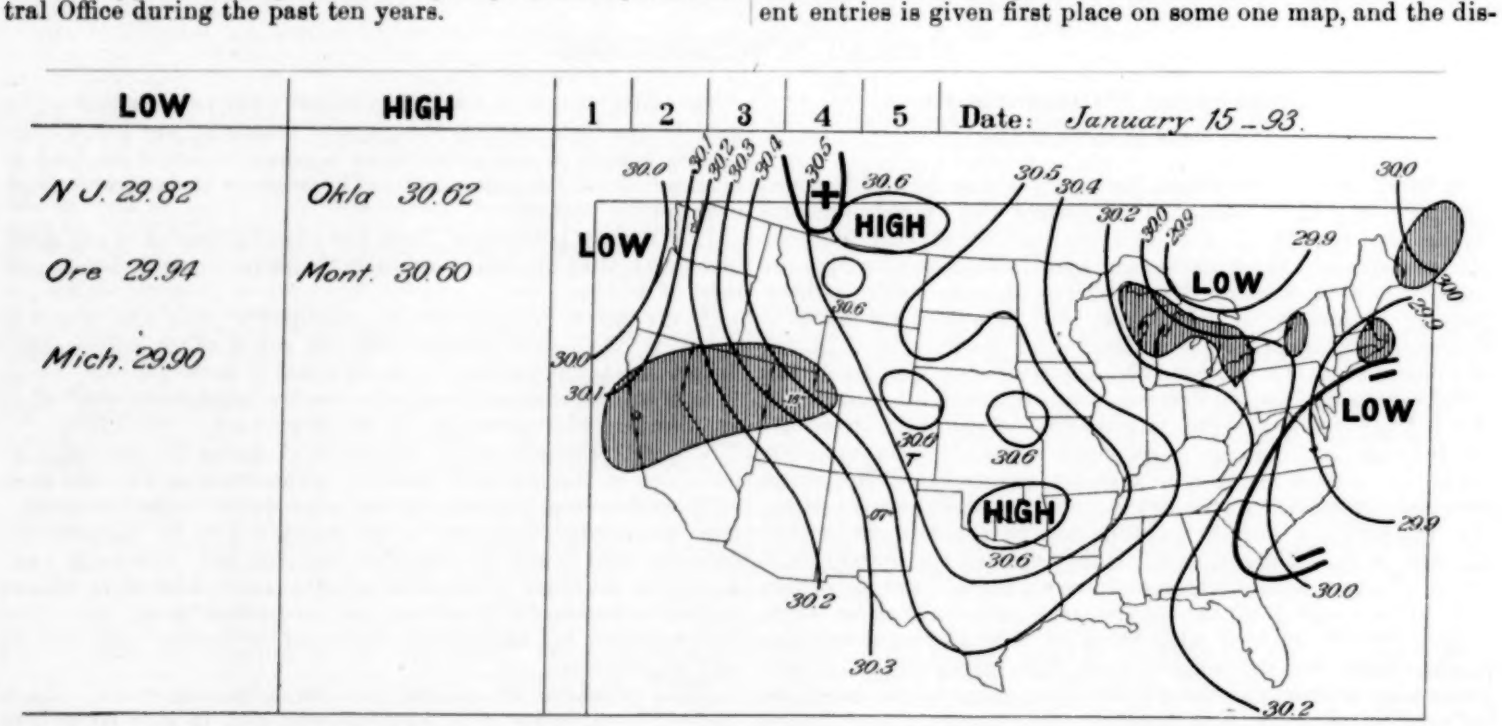


FIG. 1.—Sample map for classified file.

[1] Read before the Milwaukee Convention of Weather Bureau Officials, August 28, 1901.

in its appropriate subdivision, and the same is true of any other high area, no matter in what part of the United States it is located. In the subdivisions the maps are arranged according to type, and the total number of dates, as indicated by the number of maps, shows at a glance the prominent features of the pressure distribution for all past Januaries. Arranged in two small boxes, highs in one and lows in the other, with cards to indicate the different subdivisions, it is a matter of only a few moments to learn whether any particular type of map is rare or common during January and whether pronounced conditions follow.

Since the Washington maps must be referred to for information as to the conditions that obtained *more* than twenty-four hours after, it is very desirable that they be conveniently arranged. It has been found best to bind three months, say January, 1892, 1893, 1894, in one cover, thus making only three or four books for the entire period. Study of the temperature is facilitated if the changes as shown by the table on the map of the next day are written near the respective stations on the map under consideration. As the number of stations with changes equaling or exceeding the stationary limit is small as a rule, one is well repaid for the work of entering the data, red figures being used to indicate plus changes, and blue figures minus changes.

Since the current distribution of pressure, and whatever important conditions it brought about as regards temperature and rainfall, are graphically shown on each small map, I am of the opinion that the use of this system will facilitate the study of all types and will necessarily cause a general improvement in the daily forecasts; for no mind is capable of retaining without constant study a clear impression of the weather changes peculiar to each of the twelve months in the different topographical divisions of the United States.

A PROPOSED CLASSIFICATION AND INDEX OF WEATHER MAPS AS AN AID IN WEATHER FORECASTING.

By PROF. W. V. BROWN, Voluntary Observer, United States Weather Bureau, De Pauw University.

The writer has, since August 1894, been preserving the daily weather maps issued by the Indianapolis office of the Weather Bureau. They now constitute a file of nearly twenty-two hundred, and are arranged in a purely empirical system of classification which serves to bring together maps that present the same distribution of barometric conditions. The method of classification, together with an index of the maps, enables one to immediately find a map presenting any given combination of highs and lows, together with all maps bordering on the required one, and also the map of any given date.

The formation of the file was undertaken in the hope that a certain degree of uniformity might be found in the sequence of the maps belonging to any type.

Weather conditions are almost kaleidoscopic, yet in the twenty-two hundred maps there are found a great many instances where a type recurs several times, the maps of the different dates bearing a very close resemblance to each other.

It seems not unreasonable, in those cases where approximately identical conditions have been restored, to expect that like conditions would produce like effects, and the maps of the next succeeding day would, in each instance, also show resemblances.

This idea must not be pushed too far, or the attempt be made to prove too much. This paper has no reference to any cycle or periodicity in the weather, and no hypothesis is to be advocated; but the claim is made that in the file described above there is abundant evidence that when a condition or type does, through any causes whatever, recur, there is a tendency toward similarity in the maps next following; this similarity sometimes persists for three or four days before being gradually lost, it sometimes extends to the most minute and exact degree, and in any case it ought to be reckoned with in the making of weather predictions.

I understand that Mr. F. H. Brandenburg, Forecast Official in charge of the Weather Bureau office at Denver, read a paper before the Milwaukee Convention on this same subject. As Mr. Brandenburg's paper has not yet appeared in print I am unable to judge how far we have worked on the same problem, or on parallel lines.

In illustration of the proposition advanced above, three cases are submitted, involving, respectively, precipitation, change of temperature, and a cold wave. These are not given as the best instances found, but are simply three out of the first five or six types that have been studied.

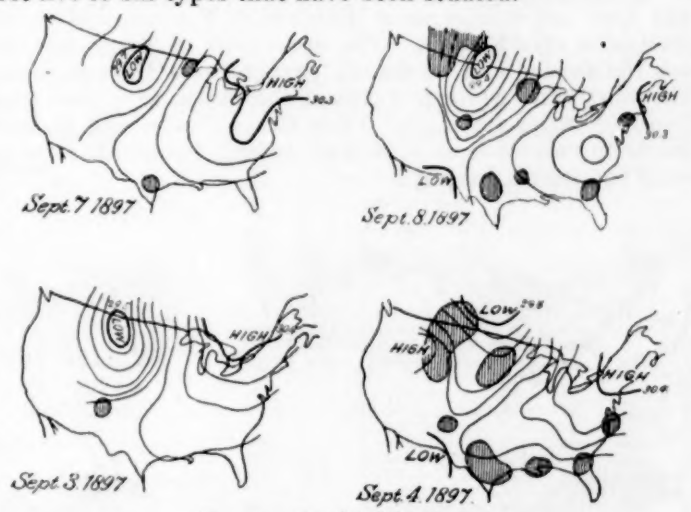


FIG. 1.—Precipitation types.

In fig. 1 we find on September 7, 1897, an approximate repetition of the conditions of September 3, and attention is called to the duplication on September 8 of the map of September 4. There is in each case a low north of Dakota, a second low south of Arizona, a high over northeastern New England, and seven rain areas alike in distribution and magnitude, (the far Northwest, the western point of Lake Superior, the middle slope of the Rocky Mountains, Texas, the vicinity of New Orleans, Jacksonville, and the middle Atlantic coast).

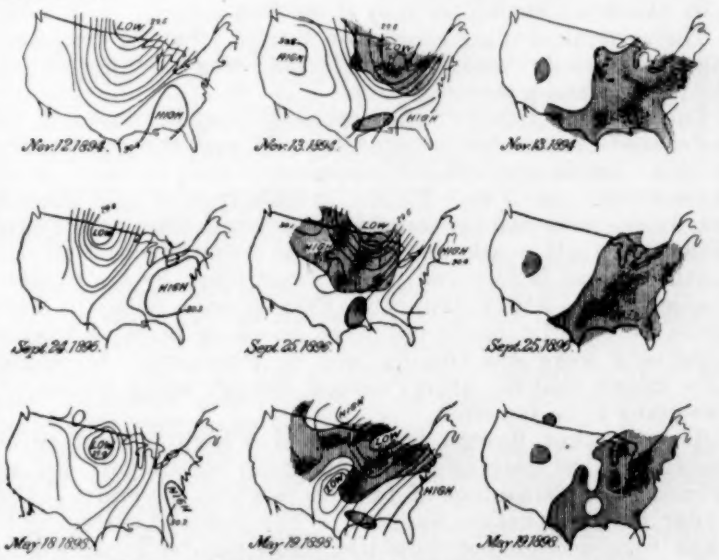


FIG. 2.—Pprecipitation and temperature types.

Fig. 2 gives, in the first vertical column, the maps of the

three dates, November 12, 1894, September 24, 1896, and May 18, 1898. These have each an energetic low over North Dakota, with a much less pronounced high over the south Atlantic coast; the difference between adjacent high and lows is nine-tenths of an inch in the first and second cases, and eight-tenths in the third. In the second column are the maps of the next succeeding days showing the distribution of rainfall. A large rain area has developed over the Lake region, but the small detached area of rainfall over New Orleans is to be especially noted. The variation in the shading is proportional to the amount of the rainfall. The third column gives the change of temperature for the same dates. The areas shaded with vertical lines represent those with rising temperature. The rest have falling temperature. The detached area of rising temperature at Denver is to be noted, also a small area on the Atlantic coast having falling temperature; in the first and second cases it occurs at Norfolk, and in the third case is over Florida. The main line of separation between the shaded and unshaded parts crosses Lake Superior at the north and western Texas at the south, with less than a hundred miles variation. Over Lakes Huron and Ontario there is in two cases an area with falling temperature penetrating the region having a rise.

CLASSIFIED WEATHER TYPES.

By E. B. GARRIOTT, Professor of Meteorology.

Classified weather types have been a recognized aid to forecasting for many years. Unfortunately, however, the work of classification has not, until recently, been systematically attempted, and the results obtained have, therefore, formed a part of the personal experience of individual forecasters, rather than a fund of information compiled and preserved in a form for ready reference. The failure to record in a permanent form the results of studies of weather types has been largely due to the fact, that previous to the last twelve months, the region covered by telegraphic reports was too limited in area to admit of a satisfactory classification of weather types for use in the current work of forecasting, and also, in part, to the great amount of time and labor involved in making these records.

During the entire history of the Weather Bureau (at least since July, 1872), forecasters have been assigned to certain months in advance with instructions to make special preparations for the work by a diligent study of weather conditions for corresponding months and seasons of previous years. These instructions have, as a rule, been faithfully followed,

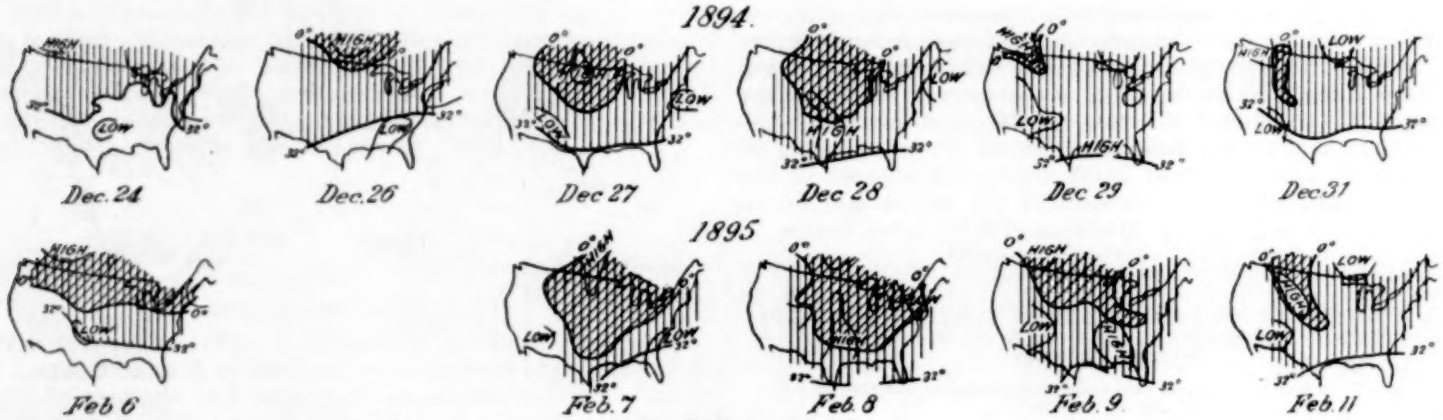


FIG. 3.—Cold wave types.

Fig. 3 gives two series of maps beginning, respectively, Monday, December 24, 1894, and Wednesday, February 6, 1895. These will be recognized as the two cold waves that brought such destruction to the orange groves of Florida. The maps are arranged so that each one of the second series falls under the analogous map of the first series.

The vertical shading shows the territory having temperatures between 32° and zero, while the cross hatching shows the region having zero and lower.

The close repetition of the first series that is presented in the second can not fail to impress itself, and the persistence of this likeness through five consecutive days becomes most remarkable. As is well known, in this type of cold wave a low moves from Dakota southward to Texas, then to the east along the Gulf coast, and along the Atlantic coast to the northeast, and is followed in the same track by a strongly-marked high. On February 6, 1895, anyone with the first series before him could not have failed to perceive that a great cold wave was coming, and on February 7 he would have known that the great freeze of the preceding December was going to be repeated.

The Weather Bureau has attained a high percentage of success in the forecasts, and anything which will aid in reducing the percentage of failures is worth the effort. The writer believes that, in support of the index or system outlined here, enough corroborative cases can be furnished to constitute a demonstration of its usefulness as an aid and check in weather forecasting.

and during the months of their assignment the forecasters have been alert to discover in past records types of weather of a character to aid them in their current work.

With increased experience, forecasters learn that satisfactory forecasts can not be made from single maps, or from a single set of maps. They learn that successful forecasting requires that the history of the conditions which single maps present must be studied and considered, and that for use in forecasting this information must be obtained from personal experience with similar types, strengthened by reference to past records. They discover that dissimilar changes and conditions frequently result from apparently similar maps, and, therefore, that apparently similar maps, as regards pressure and temperature distribution, do not, necessarily, belong to the same type.

Corresponding weather types must present atmospheric formations and movements of the same general character extending over periods of several days. When types of this character can be found in past records which correspond with current conditions, forecasts can be safely made for several days in advance. The possibility of making forecasts of this kind was recognized some years ago, when the writer was engaged in compiling and charting international observations and storm tracks of the Northern Hemisphere. Proof of the feasibility of making forecasts for periods of several days by the aid of classified maps has been secured in experimental work during the past year.

The experimental work referred to has been conducted by

the aid of telegraphic reports received from western Europe, islands of the North Atlantic Ocean, and North America, and by a classification of types prepared by the aid of Weather Bureau and international reports. These preliminary studies appear to indicate recurring periods during which similar weather conditions and changes obtain generally over the middle latitudes of the Northern Hemisphere. A determination of these periods, with the data available, may not be possible.

The increased accuracy of the forecasts and the lengthening of the period for which they are made, which will surely follow a vigorous prosecution of this line of work, will, however, justify the great expenditure of time, labor, and skill which the preparation of reference charts and their classification will demand.

HAWAIIAN CLIMATOLOGICAL DATA.

By CURTIS J. LYONS, Territorial Meteorologist.

Meteorological observations at Honolulu, December, 1901.

The station is at 21° 18′ N., 157° 50′ W.

Hawaiian standard time is $10^h\ 30^m$ slow of Greenwich time. Honolulu local mean time is $10^h\ 31^m$ slow of Greenwich.

Pressure is corrected for temperature and reduced to sea level, and the gravity correction, —0.06, has been applied.

The average direction and force of the wind and the average cloudiness for the whole day are given unless they have varied more than usual, in which case the extremes are given. The scale of wind force is 0 to 12, or Beaufort scale. Two directions of wind, or values of wind force, or amounts of cloudiness, connected by a dash, indicate change from one to the other.

The rainfall for twenty-four hours is measured at 9 a. m. local, or 7.31 p. m., Greenwich time, on the respective dates.

The rain gage, 8 inches in diameter, is 1 foot above ground. Thermometer, 9 feet above ground. Ground is 43 feet, and the barometer 50 feet above sea level.

Date.	Pressure at sea level.	Temperature.		During twenty-four hours preceding 1 p. m. Greenwich time, or 2:30 a. m. Honolulu time.									Total rainfall at 9 a. m., local time.
				Temperature.		Moisture.		Wind.		Average cloudiness.	Sea-level pressures.		
		Dry bulb.	Wet bulb.	Maximum.	Minimum.	Dew-point.	Relative humidity.	Prevailing direction.	Force.		Maximum.	Minimum.	
	*	†	†			‡	‡		§				
1	30.01	64	63.3	79	63	64.0	80	sw.	1-0	3-0	30.03	29.94	0.00
2	29.95	70	68.7	82	63	66.5	80	n.	1-0	1-9	30.05	29.91	0.00
3	29.98	74	67	81	68	68.5	82	sw.	1-0	5	30.04	29.93	0.00
4	29.99	74	67.5	80	66	63.7	67	ne	2-0	4	30.05	29.95	0.00
5	30.01	74	67	79	72	64.3	67	ne.	2	6	30.06	29.97	0.00
6	29.96	73	65.5	80	73	63.0	64	ne	4	3	30.04	29.95	0.00
7	29.88	70	66	79	72	63.3	66	ne.	4-0	3	29.99	29.86	0.00
8	29.82	69	66	80	66	65.5	75	e-se.	1-0	1-3	29.90	29.80	0.09
9	29.81	64	63.3	74	66	65.7	88	w.	1-0	10-8	29.92	29.80	0.21
10	29.77	65	64	79	63	65.5	84	sw-n.	0	1-5	29.85	29.75	0.00
11	29.80	70	62	78	64	65.0	84	sw-w.	0-1	2	29.82	29.73	0.00
12	29.91	69	60	76	64	56.5	58	nw-n.	1-5	1	29.93	29.83	0.00
13	29.88	60	58	75	67	55.0	61	n	3-0	1-0	29.97	29.87	0.00
14	29.77	74	68	77	59	61.0	74	n-sw.	1-3	0-10	29.90	29.78	0.00
15	29.85	74	69	80	73	66.7	74	wsw.	3-4	5	29.87	29.76	0.00
16	29.86	75	69	80	72	67.5	75	wsw.	2	5	29.93	29.84	0.00
17	29.81	75	69	80	74	65.7	68	sw.	3	6	29.91	29.80	0.01
18	29.80	73	71	79	73	66.5	72	sw.	3-4	7-10	29.86	29.76	1.04
19	29.94	72	69.5	77	71	70.5	92	w-var.	0	10-8	29.94	29.80	0.22
20	30.05	67	65	79	68	68.0	84	se.	1-0	5-0	30.07	29.92	0.00
21	30.00	65	64	80	64	67.7	83	se.	1-0	0-5	30.09	29.98	0.00
22	29.86	69	66	79	64	66.7	85	sw.	1-0	1-7	30.03	29.86	0.04
23	29.80	65	64.7	70	67	64.5	91	w-n.	3-0	8-10	29.88	29.74	1.73
24	29.81	71	63	78	64	65.3	80	ne.	0-2	5-10	29.86	29.73	0.46
25	30.01	69	66.5	76	68	67.7	92	se-e.	3-0	10	30.06	29.78	5.76
26	30.00	68	67.3	78	64	65.5	81	nne.	1-0	10-8	30.11	29.96	0.01
27	29.97	69	68.3	79	67	67.0	85	ne	0-3	8-4	30.06	29.94	0.10
28	29.91	69	68.3	77	67	68.5	87	sw.	1	8-4	29.98	29.89	0.20
29	29.97	68	61	73	67	64.0	84	nw-n.	1-6	10-2	29.99	29.89	0.10
30	30.06	67	59	72	65	56.5	65	nne.	5-7	3	30.06	29.95	0.00
31	30.11	66	59	71	65	52.3	56	n.	3-2	3	30.13	30.04	0.01
Sums.													9.98
Means.	29.926	69.4	65.5	77.4	67.1	64.1	76.2		1.7	5.0	29.980	29.862	
Departure.	—0.047					+1.1	+1.2			+0.6			+6.06

*This pressure is as recorded at 1 p. m., Greenwich time. †These temperatures are observed at 6 a. m., local, or 4:31 p. m., Greenwich time. ‡These values are the means of (6+9+2+9) ÷ 4. §Beaufort scale.

Mean temperature for December, 1901, 72.1°; normal is 71.5°. Mean pressure for December, 1901, 29.923; normal is 29.970.

GENERAL SUMMARY FOR NOVEMBER, 1901.

Temperature mean for the month, 73.9°; normal, 73.8°; average daily maximum, 78.9°; average daily minimum, 69.0°; average daily range, 9.9°; greatest daily range, 16°; least daily range, 3°; highest temperature, 82°; lowest, 63°.

Barometer average, 29.983; normal, 29.957 (corrected for gravity by —.06); highest, 30.18, on the 15th; lowest, 29.85, on the 27th; greatest 24-hour change, i. e., from any hour on one day to the same hour on the next, .09. Lows passed this point on the 7th and 27th; highs, on the 15th and 23d.

Relative humidity, 76.5 per cent; normal, 76.0; mean dew-point, 66.2; normal, 65.7; mean absolute moisture, 7.08 grains to the cubic foot; normal, 6.93.

Rainfall, 3.34 inches; normal, 5.52; rain record days, 18; normal, 17; greatest rainfall in one day, 0.80, on the 7th; total at Luakaha (Nuuanu near Pali) 14.76; at Kapiolani Park, 1.63. Total rainfall since January 1, 32.30; normal, 32.76.

Rainfall data.

Stations.	Elevation.	Nov., 1901.
HAWAII.		
HILO, e. and ne.	*Feet.*	*Inches.*
Waiakea	50	36.09
Hilo (town)	100	38.89
Kaumana	1,250	44.69
Pepeekeo	100	25.56
Hakalau	200	29.16
Honohina	300	35.86
Laupahoehoe	500	28.30
Ookala	400	21.47
HAMAKUA, ne		
Kukaiau	250	13.35
Paauilo	750	17.67
Paauhau (Mill)	300	10.39
Paauhau (Greig)	1,150	.....
Honokaa (Muir)	425	10.15
Honokaa (Rickard)	1,900	.....
Kukuihaele	700	7.74
KOHALA, n.		
Awini Ranch	1,100	.....
Niulii	300	8.41
Kohala (Mission)	521	6.90
Kohala (Sugar Co.)	235	.....
Hawi	300	.....
Hawi Mill	600	.....
Waimea, c	2,720	2.95
KONA, w.		
Kailua	930	6.72
Holualoa	1,370	9.40
Kealakekua	1,580	6.99
Napoopoo	25	.59
KAU, se.		
Kahuku Ranch	1,680	.....
Honuapo	15	10.43
Naalehu	650	11.29
Hilea	310	10.10
Pahala	850	6.35
Moaula	1,700	12.58
PUNA, e.		
Volcano House	4,000	17.72
Olaa (Sugar Company)	221	31.47
Olaa (Mountain View)	1,690	45.86
Kapoho	110	14.80
Kalapana, se	8	.....
MAUI.		
Lahaina	.....	.....
Waiopae Ranch	700	5.49
Kaupo (Mokulau), s	285	18.41
Kipahulu, s	300	18.01
Kahikinui	1,550	.....
Hamoa Plantation, se	60	11.85
Nahiku (Anderson), ne	60	13.59
Nahiku, (Nishwitz), ne	850	20.78
Haiku n	700	7.94
Kula (Erehwon), n	4,500	2.89
Kula (Waiakoa)	2,700	3.17
Puuomalei, n	1,400	.....
Paia, n	180	2.98
MAUI—*Continued.*	*Feet.*	*Inches.*
Haleakala Ranch, n	2,000	10.56
Wailuku, ne	200	3.56
LANAI.		
Keomuku, e	.....	.....
OAHU.		
Punahou (W. B), sw	47	3.34
Kulaokahua, sw	50	2.90
Makiki Reservoir	120	3.98
Kewalo (King street), sw	15	2.99
U. S. Naval Station, sw	6	1.95
Kapiolani Park, sw	10	1.63
Manoa (Woodlawn Dairy), e	285	7.07
School street (B shop), sw	70	4.42
Pacific Heights, sw	700	7.15
Insane Asylum, sw	30	3.51
Kalihi-uka	.....	.....
Kamehameha School	75	3.06
Nuuanu (W. W. Hall), sw	50	4.21
Nuuanu (Wyllie street), sw	250	7.24
Nuuanu (Elec. Station), sw	405	6.33
Nuuanu (Luakaha) c	850	14.76
Waimanalo, ne	25	.....
Maunawili, ne	300	6.18
Kaneohe, ne	100	.....
Ahuimanu, ne	350	.....
Kahuku, n	25	2.80
Waialua, n	20	1.39
Wahiawa, c	900	1.86
Ewa Plantation, s	60	0.72
Waipahu, s	200	1.71
Moanalua, sw	15	2.72
KAUAI.		
Lihue (Grove Farm), e	200	4.95
Lihue (Molokoa), e	300	4.44
Lihue (Kukaua), e	1,000	8.66
Kealia, e	15	2.88
Kilauea, ne	325	6.01
Hanalei, n	10	14.15
Waiawa, sw	32	1.09
Eleele, s	200	3.42
Waiawa, Mountain, s	2,100	21.35
McBryde (Residence)	850	9.78
Lawai	450	0.06
Delayed October reports.		
Haleakala Ranch	.....	0.65
Kihahulu	.....	4.86
Waiopae Ranch	.....	1.99
Ewa Plantation	.....	3.85
Paauilo	.....	5.10
Laupahoehoe	.....	10.01
Napoopoo	.....	0.57
Nuuanu (Wyllie Street)	.....	5.40
Kapoho	.....	5.09
Hakalau	.....	8.70
Honohina	.....	13.79

The artesian well water has risen during the month from 33.12 to 33.56 feet above mean sea-level. On December 1, 1900 it stood at 33.62. The average daily mean sea level for November was 10.21 feet on the scale, 10.00 representing an assumed annual mean, and 9.82 the actual annual mean for nine years previous to 1901.

Trade wind days, 23 (5 of north-northeast), normal, 17; average force (during daylight) Beaufort scale, 2.6. Cloudiness, tenths of sky, 5.5; normal, 4.6.

Approximate percentages of district rainfall as compared with normal: Hilo, 300 per cent; Hamakua, 180; Kohala, 180; Waimea, 150; Kona, 125; Kau, 175; Puna, 170; Maui, east

coast, 200; Central, 120; Oahu, coast, 60 per cent; interior, 135; Kauai, 70 per cent.

The following heavy 48-hour rainfalls are noted: Olaa, Mountain View, 1,690 feet elevation, 30 inches on the 8th and 9th; Kaumana, 28.07 in 48 hours; Hilo (town), 26.08; same time, Waiakea, 24.62; same date, Paauilo, 12.46; two days, Ookala, 14.16.

Mean temperatures: Pepeekeo, Hilo district, 100 feet elevation, average maximum, 77.0°; average minimum, 68.6°; Waimea, Hawaii, 2,730 elevation, 73.9° and 63.0°; Kohala, 521 feet elevation, 76.8° and 68.3°; Olaa, Mountain View, 70.0 and 60.0; Waiakoa, Kula, 2,700 elevation, 75.5° and 59.0°; W. R. Castle's, Kulaokahua, 60 feet elevation, highest, 85°; lowest, 65.0°; mean, 73.6°; Ewa Mill, 50 feet elevation, average maximum 82.6°; average minimum, 67.1°; dew-point and relative humidity at same station, 67.6° and 79.0 per cent.

The main event of the month was the torrential downpour on Hawaii, mostly on the 8th and 9th, accompanied by north-northeast to east-northeast gales throughout the group. The rain was only moderate on Oahu and Kauai. There was an unusual absence of southerly weather for the month. Snow fell on Mauna Loa and Mauna Kea from the 5th to the 10th.

Earthquake at Hilo, 15th at 10 p. m., also a light one on the 21st. Heavy surf 8th to 14th.

NOTE.—A marked depression passed here on the 10th, the lowest barometer reading being about 29.93 inches. The wind shifted from west to southwest, then to northwest and ended with a norther on the 11th and 12th, which was a "Kona" at other points in the group. Another low passed on the 17th, and a third on the 23d. Quite likely these two latter were in reality one and the same, since the wind, during the passage of this first depression backed from north to southwest and then to northeast, giving Honolulu 5.76 inches of rain on the 24th.

GENERAL SUMMARY FOR DECEMBER, 1901.

Temperature mean for the month, 72.1°; normal, 71.5°; average daily maximum, 77.4°; average daily minimum, 67.1°; mean daily range, 10.3°; greatest daily range, 19°; least daily range, 3°; highest temperature, 82°; lowest, 59°.

Barometer average, 29.923; normal, 29.970 (corrected for gravity by —.06.); highest, 30.17, on the 31st; lowest, 29.73, on the 10th; greatest 24-hour change, i. e., from any given hour on one day to the same hour on the next day, 0.23; lows passed this point on the 10th and 22d; highs, on the 4th, 20th, and 31st. In the October report the following remark was made: "It will be interesting to note whether seven successive months of low barometer will be followed by unusually heavy rains." The report below will show whether this was well founded.

Relative humidity, 76.2; normal, 75; mean dew-point, 64.1°; normal, 63°; mean absolute moisture, 6.63 grains to the cubic foot; normal, 6.32. The dew-point was unusually low during the last three days of the month.

Rainfall, 9.98 inches; normal, 3.92; rain record days, 14; normal, 16; greatest rainfall in one day, 5.76 inches, on the 24th; total at Luakaha, 25.51; at Kapiolani Park, 9.33. Total rainfall since January 1, 38.96; normal, 37.00.

The artesian well level rose during the month from 33.56 to 34.05 feet above mean sea level. January 1, 1901 it stood at 34.00. It would seem that the lowering of the wells has come to a standstill, owing to the failure of the high level wells, and probably greater economy on the part of those at a low level.

The average daily mean sea level for December was 10.26 on the scale, 10.00 representing an assumed annual mean, and 9.82 the actual annual mean for nine years previous to 1901.

The following figures are from actual hourly measurements on sheets from self-recording tide gage made by Hugo Bilgnam, Stienle's pattern, and referred daily to standard bench mark. The work has been done by the Hawaiian Government Survey—now Territorial Survey—and the results are furnished by permission of the present surveyor: 1892, 9.869 feet; 1893, 9.844; 1894, 9.758; 1895, 9.688; 1896, 9.848; 1897, 9.969; 1898, 9.848; 1899, 9.690; 1900, 9.837; 1901, 10.173. Mean, 9.852.

Trade wind days, 7; normal, 14; 3 of north-northeast; average force of wind (during daylight), 1.7 Beaufort scale. Cloudiness, tenths of sky, 5.0; normal, 4.4

Approximate percentages of district rainfall, Hilo, 175 per cent; Hamakua, 140; Kohala, 130; Waimea, 100; Kona, 200 to 400; Kau, 175; Puna, 150; Maui, variable from 60 to 200; Oahu, 240; Kauai, 225.

There was a general and very heavy rainfall throughout the group on the 24th; 6 inches in twenty-four hours on Oahu, 10 inches in twenty-four hours in Hilo; at Ookala, north Hilo, 20 inches in twenty-four hours is reported on good authority, and at Laupahoehoe, Hilo, 30.50 inches is officially reported for the 24th and 10.80 for the 25th, which latter fell in the early part of the day, making 41.30 inches in the period of twenty-eight hours, a record that it is believed has only been surpassed by one in Queensland of 40 inches in twenty-four hours.

Rainfall data.

Stations	Elevation.	Dec., 1901.	Stations.	Elevation.	Dec., 1901.
HAWAII.			**MAUI—*Continued.***		
HILO, e. and ne.	*Feet.*	*Inches.*		*Feet.*	*Inches.*
Waiakea	50	12.79	Puuomalei, n	1,400	5.80
Hilo (town)	100	.....	Pala, n	180	3.06
Kaumana	1,250	14.70	Haleakala Ranch, n	200	8.42
Pepeekeo	100	14.81	Wailuku ne	200	3.96
Hakalau	200	14.98	OAHU.		
Honohina	300	25.78	Punahou (W. B.) sw	47	9.98
Laupahoehoe	500	49.07	Kulaokahua, sw	50	9.52
Ookala	400	.....	Makiki Reservoir	120	9.60
HAMAKUA, ne.			Kewalo, (King street), sw	15	.....
Kukaiau	250	9.79	U. S. Naval Station, sw	6	8.29
Paauilo	750	11.82	Kapiolani Park, sw	10	9.33
Paauhau (Mill)	300	6.70	Manoa (Woodlawn Dairy) c	285	13.39
Paauhau (Greig)	1,150	.....	School street, (Bishop), sw	50	8.76
Honokaa (Muir)	426	6.86	Pacific Heights, sw	700	10.10
Honokaa (Rickard)	1,000	.....	Insane Asylum, sw	30	8.62
Kukuihaele	700	6.43	Kalihi-uka, sw	200	14.74
KOHALA, n.			Kamehameha School	75	8.71
Awini Ranch	1,100	.....	Nuuanu (W. H. Hall), sw	50	9.78
Niulii	300	2.80	Nuuanu (Wyllie street), sw	230	11.39
Kohala (Mission)	521	5.01	Nuuanu (Elec. Station), sw	405	13.29
Kohala (Sugar Co)	235	5.72	Nuuanu (Luakaha) c	850	25.51
Hawi Mill	600	.....	Waimanalo, ne	25	15.39
Waimea	2,730	4.33	Maunawili, ne	300	17.31
KONA, w.			Kaneohe, ne	100	.....
Kailua	950	.....	Ahuimanu, ne	350	17.04
Kealakekua	1,580	7.07	Kahuku, n	25	7.79
Holualoa	1,350	4.75	Waialua, n	20	7.07
Napoopoo	25	3.45	Waialawa, c	900	10.32
KAU, se.			Ewa Plantation, s	60	7.80
Honuapo	15	4.87	Magnetic Station U. S. C. S.	45	9.03
Naalehu	650	5.82	Waipahu, s	200	7.62
Hilea	310	6.30	Moanalua, sw	15	9.62
Pahala	850	7.24	KAUAI.		
Moaula	1,700	12.62	Lihue (Grove Farm), e	200	7.02
PUNA, e.			Lihue (Molokoa), e	300	8.65
Volcano House	4,000	10.93	Lihue (Kukaua) e	1,000	10.44
Olaa (Mountain View)	1,700	14.92	Kealia, e	15	6.45
Kapoho	110	9.43	Kilauea, ne	325	13.73
Kalapana se	8	.....	Hanalei, n	10	15.41
MAUI.			Waiawa, sw	32	6.72
Walopae Ranch s	700	5.17	Eleele, s	200	.....
Kaupo (Mokulau) s	285	11.27	Waiawa, Mountain, s	2,100	.....
Kipahulu s	300	12.17	McBryde (Residence)	850	10.18
Hamoa Plantation se	60	5.82	Lawai	450	10.99
Nahiau, (Anderson), ne	60	5.57	*Delayed November reports.*		
Nahiku, (Nishwitz), ne	800	16.55	Kahuku, Pine Grove	1,680	8.02
Huiku n	700	4.37	Kohala Sugar Co	234	10.75
Kula, (Erehwon) n	4,500	.....			

Mean temperatures: Pepeekeo, Hilo district, 100 feet elevation, average maximum, 77.6°; average minimum, 67.8°; Waimea, Hawaii, 2,730 feet elevation, 73.7° and 61.6°; Kohala, 521 feet elevation, 78.6° and 67.7°; W. R. Castle, Kulaokahua, 60 feet elevation, highest, 80°; lowest, 59°; average for year, 74.42°. Ewa Plantation, 50 feet elevation, mean maximum, 81.2°; mean minimum, 64.8°; mean dew-point, 64.4°.

The two storm periods of the month were about the 8th and

24th, both preceded by heavy swell and followed by low dew-point. The north wind evidently precipitated the terrific downpour on north Hilo. There was lightning reported from Hawaii for the 8th, 9th, 13th, 24th, and 25th, and Maui on the 8th. Snow fell on Mauna Kea and Mauna Loa on the 8th and 24th; on Haleakala on the 8th or 9th. Earthquake reported at Hilo, 7:30 p. m. on the 2d.

AN AURORAL-LUNAR HALO DISPLAY.

H. H. TEN BROECK, Braidentown, Fla., dated December 29, 1901.

At midnight of the 28th I observed an auroral display with an axis extending about west-northwest to east-southeast. There was at the time an unusually brilliant halo around the moon, about 45° in diameter. The upper half was fringed on the edge by rays about 3° or 4° long, a few much longer, radiating, not from the moon (the center of the halo), but from a point below it about east-southeast on the horizon. Some of the rays extended northward as far as Cassiopeia while the Pleiades were a little south of the center of the long bands, which converged toward a point about west-northwest on the horizon, although not reaching it by 10° or 15°. The bands and the rays on the halo appeared and disappeared slowly like auroral bands and were of a pale white color. There was an 8 or 10 mile southeasterly wind blowing and half of the sky was covered with very light clouds of a cirro-cumulus order, with an almost imperceptible motion. Very few of the bands extended below the moon. The fringe of rays on the upper edge of the halo was well marked and closely resembled that often seen on an auroral arch; it, too, changed in brightness, slowly, as well as in length. It was a well-marked auroral display, with the moon's halo as a starting point. In half an hour the halo and bands had disappeared as well as most of the clouds.

I have never before seen or heard of an aurora from a lunar halo, nor one with its middle line running west-northwest and east-southeast.

MEXICAN CLIMATOLOGICAL DATA.

Through the kind cooperation of Señor Manuel E. Pastrana, Director of the Central Meteorologic-Magnetic Observatory, the monthly summaries of Mexican data are now communicated in manuscript, in advance of their publication in the Boletin Mensual. An abstract, translated into English measures, is here given, in continuation of the similar tables published in the MONTHLY WEATHER REVIEW since 1896. The barometric means are now reduced to standard gravity.

Mexican data for December, 1901.

Stations.	Altitude.	Mean barometer.*	Temperature.			Relative humidity.	Precipitation.	Prevailing direction.	
			Max.	Min.	Mean.			Wind.	Cloud.
	Feet.	*Inch.*	° *F.*	° *F.*	° *F.*	%	*Inch.*		
Chihuahua	4,669	25.33	80.6	23.0	53.8	47	.....	ne.	.....
Guadalajara (Obs. del. Est.)	5,186	24.90	83.7	40.1	58.1	51	.....	n.	.....
Guanajuato	6,640	23.66	79.2	30.7	57.0	49	.....	wsw.	.....
Leon (Guanajuato)	5,906	24.27	73.6	28.6	54.7	59	0.05	nw.	.....
Mazatlan	25	29.89	79.5	55.9	70 0	71	T.	nw.	w.
Merida	50	29.94	93.2	48.9	71.4	75	0.16	ne.	.....
Mexico (Obs. Cent.)	7,472	23.01	71.2	30.9	52.5	51	T.	n.	.....
Monterrey (Sem.)	1,626	28.20	97.7	31.1	57.9	54	.....	ne.	.....
Morelia (Seminario)	6,401	23.91	73.0	30.2	54.9	60	.....	sw.	.....
Puebla (Col. Cat.)	7,125	23.30	71.6	35.6	55.6	57	0.02	e.	.....
Puebla (Col. d. Est.)	7,118	23.32	72.3	36.6	53.6	60	0.06	ene.	.....
Saltillo (Col. S. Juan)	5,399	24 76	72.7	28.9	51.4	55	.....	sw.	.....
Toluca	8,812	21.92	68.7	20.1	47.1	55	0.05	w.	.....
Tuxtla (Gutierrez, Chispas).	1,864	28.10	94.6	47.8	71.8	72	.....	nw.	.....
Zapotlan	5,078	25 05	77.0	41.7	60.4	51	T.	n.	.....

* Reduced to standard temperature and gravity.

THE PHYSICAL BASIS OF LONG-RANGE WEATHER FORECASTS.[1]

By PROF. CLEVELAND ABBE.

The expression "long range" must not be misunderstood. It refers only to the length of time intervening between the date of making a weather prediction and the date when we expect it to be fulfilled. At the present time, by the help of the daily weather map, the official weather forecasters of this country, and indeed of every civilized nation on the globe, publish forecasts, in detail, of approaching weather changes, and especially storms, for one and two, or possibly occasionally three days in advance. These predictions all relate to comparatively minute details for regions that have been charted and studied daily for many years. They merely represent the direct teachings of experience; they are generalizations based upon observations but into which physical theories have as yet entered in only a superficial manner if at all. They are, therefore, quite elementary in character as compared with the predictions published by astronomers, based on the laws of gravitation and inertia, or the predictions sometimes offered by chemists, based on the laws that are being worked out by these investigators. Even the electrician, familiar with mathematical physics ventures on predictions based on far more complex theories than are as yet at the command of the meteorologists. But the latter are slowly building a grand structure, mathematical, graphical, and numerical, in which deductive reasoning will take the place of empirical rules. The whole will eventually form a complex intellectual machine, by means of which the general, and possibly the detailed phenomena of the atmosphere, will be followed up day by day. Then we shall be justified in calling our work rational science, as distinguished from empirical science. I use the word science in its fundamental meaning, as referring to that of which we have accurate knowledge, and not that which is purely speculative.

While I thus indulge hope in the prospective future high perfection of the science of the weather, I recognize the fact that we must not expect to realize these hopes in this generation. The progress of all science is necessarily slow. From Copernicus to Kepler, from Kepler to Newton, from Newton to La Place, and from La Place to the living giants in the theoretical astronomy of to-day, we proceed by steps of a century each. In chemistry, from Berzelius to the present day, we have scarcely one such step. In electrical science we are less than a century distant from Ohm and Green. In meteorology, considered as an application of physics, we begin with Espy's work of 1830, but considered as a branch of mathematical science we begin with Ferrel's work of 1856. The development of a correct "Theoria meteorologica" has made good progress during the past twenty years, but we are still at work on the introductory chapter. Some would hasten the work by unnatural stimulants in response to the feverish anxiety of the people and the daily newspapers, but we must be content to await the surer results of a slow but natural growth. Personally, I hope I may live to see the day when some of our universities will offer attractive courses in dynamic, experimental, and observational meteorology to advanced students of mathematics and physics, when those who are prepared to profit by such lectures may in their turn contribute to the advancement of our knowledge. It will not do for us to be so absorbed in so-called practical work as to neglect the research work that is still more practical. The practical work of to-day is but the application of the results of the past research. The research of to-day will be the basis

[1] This paper is a summary of lectures delivered at Johns Hopkins University in February, 1901. It was prepared for the meeting of the American Association for the Advancement of Science, Denver, August, 1901, and is now first published.

of the practical work of the future, and so on, step by step. At the present time this important branch of physical and mathematical science is recognized in German and French universities, but has not yet taken its proper place in American or English institutions. It demands not merely a few lectures or an occasional mention, but the complete devotion of at least one professor and one post graduate student annually.

At the present time it is, of course, impossible to make long-range forecasts of the details that make up the daily weather, but there is a large class of the community that would be greatly benefitted and perhaps perfectly satisfied if we could forecast the general features of a season, such as a week, or a month, a spring or summer, an autumn or winter. This class of work we call seasonal or climatological forecasts. It is desired to know whether on the average there will be many frosts or severe freezing weather, whether the range of temperature will be large or small, whether it will be especially cloudy or sunny, whether the rain or snow will be abnormally large or small, or whether having fallen in abundance it will evaporate too rapidly to be utilized for irrigation. Such seasonal forecasts have been considered as a possibility, even though accurate long-range weather predictions may not be so. The anxiety of farmers with regard to their future crops has led them from time immemorial to look about for natural signs, and they find them everywhere. If the moon is in a certain position, they say that it indicates a wet month; if the wild geese fly very high on their journey northward, it indicates a dry summer; if the woodchuck goes back into his burrow, it means a long, cold spring; if the celestial milky way happens to trend in a northwest direction when the farmer happens to look at it, it means a prevalence of cold, northwest winds; if the trees leaf out early, it means an early spring; if the fur of the wild animals is unusually thick, or if a squirrel is laying up a large store of food, it means a long, hard winter; and so we might go on indefinitely, as though the animals and even the trees know more about the laws of nature than man himself. When man stoops to learn from these about matters that he ought to study out for himself, he is on the downward road, wandering away from the higher intellectual light that ought to illumine his path. The little that the animals have learned and inherited after ages of experience and the little that man learned about the laws of nature during his unintellectual ages of savagery and barbarism are as nothing compared with that which the past century of civilization has revealed to the man of the present intellectual age.

There is a physical basis for all meteorological phenomena. There are laws of mechanics and heat that apply to the atmosphere, and as fast as we acquire the ability to discover these and reason out their consequences we shall perceive that law and order prevail in all the complex phenomena of the weather and the climate. Those who, for want of previous training, do not easily follow this method of presenting the problem will at least recognize that its fundamental principles are correct and that the methods of study are appropriate. We hope that the following sketch will stimulate some to take up our problems in earnest and devise either graphical, analytical, or numerical methods of resolving special questions.

I think all will agree that if we are to predict a rain or snow from fundamental premises by a rational deductive process, we must be able to first predict the temperature, moisture, and movement of the air. This is true whether we have in mind daily weather predictions or seasonal forecasts. The prediction of the wind, however, itself implies a knowledge of the distribution of the density of the air, and this latter is dependant upon temperature, moisture, and barometric pressure, to say nothing of the rotation of the earth on its axis and the irregularities of continents and oceans.

Some have attempted making general predictions as to the character of the weather for a few days in advance by relying primarily upon the observed distribution of large areas of high and low pressure. I was myself obliged to do this during 1869 and again in 1871 and 1872, when I did the work of weather prediction for the Weather Bureau of the Army Signal Office. A most extensive study of types was carried out by Prof. Thomas Russell in the year 1888–1893. A specimen of his results is published in his meteorology, and confirms the conclusion that prediction by types is of extremely limited value in weather forecasts. When it comes to the prediction of a season, months in advance, one must look further and deeper. First of all, it is absolutely necessary to take into consideration the condition of affairs over the whole earth; second, it is equally necessary to consider the conditions prevailing up to a very considerable height in the atmosphere; third, we must apply physical laws and not empirical rules.

Of course a full knowledge of the actual physical condition of the atmosphere at any initial moment is not now practically attainable, but we all realize our needs in this regard, and international cooperation is being invoked to accomplish that which no one nation can do alone. Assuming that the time will come when we shall have the necessary observational data, it is now our duty to prepare the way for the complete utilization of the information that will eventually be at hand. We must therefore attack the physical, mechanical, and mathematical problems relating to the general and the special circulations of the atmosphere upon the real globe as it now exists, including in our consideration the fields of snow and ice, the mountain ranges, the continents and the oceans, and not forgetting the distribution of clouds. Hitherto the problem of the general circulation has been attacked by simplifying the fundamental assumed conditions. Thus the globe has been assumed to be without friction or other resistances and of uniform perfect spherical shape; the atmosphere has been assumed to be dry and, therefore, cloudless. The thermodynamic and the hydrodynamic portions of the problem have been violently separated from each other. It is true that there are great analytical difficulties to be overcome in the application of pure mathematics to this complex problem of nature. All must recognize that the solutions of the simplified problems given us by Ferrel, Erman, Goldberg, Mohn, Sprung, Helmholtz, Marchi, Willy Wien, Oberbeck, Margules, Pockels, Moeller, Diro Kitao, and others are so far from being applicable to the preparation of long-range forecasts that we can only consider them as helpful stimuli to those who are ambitious of engaging in work upon the more difficult problems that the real atmosphere presents.

I am emboldened to state the problem in all its complexity because, on the one hand the progress already made must greatly encourage the investigator, and on the other hand the consideration of the experience of the meteorological office in India demonstrates to my mind that the problems of long-range forecasting will yield to studies based on the broadest possible theoretical and physical treatment.

We will for a moment consider, especially, the condition of affairs in India, since one of the meteorologists of that country has recently applied to us to know whether anything of theory or experience is known in America that will contribute to elucidate their phenomena.

The principal problem presented to the Indian meteorologists is the prediction of the quantity and locality and, to a certain extent, the time at which the seasonal rains, known as the southwest monsoon rain and the northeast monsoon rain, will occur, especially the former. The accompanying 15 charts [not reproduced] show, by the red shaded areas, the regions in which notable droughts have prevailed since that of

1769, in so far as they are described in the "memorandum" of the Indian meteorological office for 1900.[2] The disastrous results of these droughts is well known to all. Sometimes millions of natives starve to death. Undoubtedly the terrors of a famine in India are aggravated by the peculiar sociological institutions of that country, especially the system of caste which often forbids one set of men to help their suffering brethren of another set. Thus it happens that the destitution and suffering incident to a failure of rain and crops is necessarily enormous, and produces a severe drain upon the resources of the British Government, and those of the numerous philanthropic and missionary societies that are seeking to elevate the general standardof ci vilization in India.

Studying the problem from a meteorological point of view only, we notice, first of all, that the area covered by the droughts of 1896 and 1899, and, of course, the resulting famines of the following years, were much larger than in any preceding year since 1769. This is not to be regarded as due to any effect of deforestation, or any great increase in the population, or as locally produced by a drying up of the soil, due to several years of light rain. The tinted areas on these charts indicate an actual local temporary diminution of the rainfall, and with that, of course, a diminution of cloudiness and an increase in insolation or sunshine, as well as in the temperature and dryness of the air near the earth's surface. The evaporation from the apparently dry ground during such droughts may indeed be much greater than the evaporation during a rainy season of normal cloudiness. These variations of cloudiness and rainfall are principally and primarily due to variations in the direction, intensity, and moisture of the so-called southwest monsoon, and to changes in the horizontal breadth of the stream of air flowing from the southwest. Therefore, the prediction of drought in India has been considered to be primarily a question of the prediction of the character of the southwest monsoon wind. I do not see how we can avoid the conclusion that a long-range prediction of the character of the seasons in any portion of the United States must also be fundamentally a prediction of the character of the winds that will blow over that region. The mountain ranges that force the winds to rise and flow over them only to cool down as they rise and deposit their moisture as rain or snow, remain the same year after year, but the winds themselves and the amount of moisture in the air change continually. The first seasonal predictions of the monsoon rains were made for India in 1888, and we are warranted in saying that during thirteen years the only real failure has been that of the prediction of the monsoon season of 1899, which was the year of phenomenally great drought in that country. Of course, this failure has been a powerful stimulus to the study of methods by which to secure better results. The official forecasters of India relied necessarily at first, largely upon purely local conditions. Every condition that could be considered likely to diminish the force of the southwest monsoon was carefully studied by them. It was known that this monsoon is essentially an indraught of cool air from the Bay of Bengal and the Arabian Sea toward the heated plateau of Thibet. If, therefore, considerable snow still rested on the Himalayas and the regions northwest and northeast of India as late as March or April, this presumably would correspondingly diminish the heating effect of the sun in the springtime, and by so much diminish the indraught and the resulting monsoon rains. On the other hand, it was recognized that if the equatorial regions south of India, or even in the South Indian Ocean, were unusually warm or cold, this condition would also diminish or increase, respectively, the push of the air northward and affect the resulting monsoon. But the weather over these oceanic regions was at that time imperfectly known to the authorities at Calcutta, and it is not surprising that in the absence of this important information the predictions based only upon the condition of the air over the Asiatic Continent should occasionally go wrong. The need of studying the southern ocean was felt very early, and, finally, the funds were provided for compiling a daily chart of the monsoon area from the Himalayas, on the north, to the southern limit of navigation in the Indian Ocean at thirty-five degrees south latitude. These charts soon demonstrated that the southwest monsoon of India comes ultimately from the southeast trade winds of the South Indian Ocean. These latter winds are disturbed from their normal direction by the action of the heated continental area of Asia, Europe, and Africa, and not by that of Thibet alone. So great is the influence of the temperature and elevation, shape and extent of this Eastern Hemisphere that if we wish to study the meteorology of the globe on a proper basis, we must relinquish the assumption that the equator is the dividing line between symmetrical systems of wind in the northern and southern hemisphers. When we have adopted this radical change in the older ideas as to the general circulation of the atmosphere, we begin to be able to understand how the condition of affairs in the South Indian Ocean in March affects the condition in India in July and August, and in Japan in September; it may affect Australia, on the one hand, and the mountainous region of Central Africa, on the other, during the whole winter or rainy season of the Southern Hemisphere. In fact, the great disturbance that starts annually in the Orient seems to me to work eastward and northward, and in the course of one, two, or three years comes to be felt both in North America and in Europe.

Although the distribution of heat is the controlling factor in starting, changing, and maintaining the motions of the atmosphere, yet it is the rotation of the rugged earth on its axis that is the tremendous influence. The latter carries the air swiftly eastward, the former modifies these movements by maintaining a slow north and south interchange. It follows that the general problem of the atmospheric circulation is a discussion of the interference of these two fundamental influences. The oceans, continents, and mountains first modify the temperature of the air, and then modify its resulting motions. To appreciate the influence of the heat and vapor, or of the land and water, one must study an equal surface projection of the land hemisphere and the water hemisphere; but in order to appreciate the influence of the diurnal rotation of the globe, one must study an equal surface projection of the

[2] The following table, copied from page 32 of the memorandum on snowfall, dated June 5, 1900, as published by Mr. John Eliot, Meteorological Reporter to the Government of India, shows the location of the areas of severe drought during the past hundred and fifty years and renders the publication of the charts unnecessary:

Year.	Region of drought and area of subsequent famine.	Sq. miles.
1769.....	Bengal	100,000?
1791.....	Bombay, Hyderabad and Madras	200,000
1802.....	South Hyderabad and Deccan	150,000
1803.....	Ceded province of northwest Provinces and Central India....	100,000
1824.....	Bombay.	80,000
1837.....	Northwestern Provinces, eastern estates of Rajputana and southeastern parts of the Punjab.	80,000
1838.....	Gujarat, Cutch and Kathiawar	50,000
1860.....	Part of northwest Provinces, Punjab and neighboring states of Rajputana.	55,000
1865	Northern part of Madras, South Hyderabad, north part of Mysore, south Mahratta districts of Bombay, Orissa, Bihar and all western Bengal.	150,000 to 200,000
1868.....	Rajputana, trans-Jumna districts of northwest Provinces, north and southeast districts of central Provinces, Punjab from Jumna to Indus.	300,000
1873.....	North Bihar, part of northwest Provinces and Oudh.....	55,000
1876.....	Madras and Deccan, Mysore and south part of Hyderabad....	250,000 to 300,000
1877.....	Central Provinces, northwest Provinces and Punjab.....	150,000
1896.....	Northwest Provinces, central Provinces, Central India and Rajputana.	300,000 to 400,000
1899.....	South Punjab, Rajputana, Central India, Berar, central Provinces, Hyderabad, Bombay Presidency and parts of Orissa, Chota, Nagpur and Madras.	600,000 to 700,000

northern and southern hemispheres. Both of these projections may be so combined in one as to show not only the distribution of temperature and moisture and the diurnal rotation, but also the distribution of the great resistances to the motion of the atmosphere offered by mountains and land as compared with the ocean. The isotherms, the lines of equal vapor tension, and the lines of equal pressure, may be combined into one set of lines of equal density of the air, which lines I have called *isostaths*, or lines of equal buoyancy, when proper allowance is made for the variations of gravity.[3]

The resistances to movement, which are often summed up in the word friction, are of several kinds, namely, first and least important, the viscosity of the atmosphere; second and more important, the mechanical obstructions offered by any flat plain or rising mass of land or even by the surfaces of waves of water; third and most important, the resistance often called friction, but which I have called convectional, which term may be explained as follows. Slowly moving masses of lighter air are, during the daytime, perpetually rising from the surfaces of land and water, while swiftly moving upper masses of potentially denser air are descending to replace them; moreover, the wind that strikes an obstructing shore or mountain range, is driven upward with a less horizontal velocity, while somewhere else the upper air must descend to replace it. In this perpetual interchange of upper and lower currents or vertical convection, the upper layers, which are generally moving the faster, are slowed down by giving a portion of their momentum to the sluggish masses that rise from below, while that portion of the rapidly moving upper currents that descends is forced to lose a portion of its momentum when it comes in contact with the ground, or when it pushes along the sluggish lower layers, making them move faster. There is, therefore, by virtue of this convection, not only a redistribution but even a loss of kinetic energy over the whole globe, and the effect is greatest when and where the convection is greatest. Of course this loss of momentum is simply a case of transformation of energy, since atmospheric pressures and temperatures are thereby increased. Moreover, the appreciable portion of this lost atmospheric energy that is transmitted to the surface waters of oceans and lakes reappears in ocean currents and in changes in the level or gradient of the ocean surface.[4] The diurnal variation in insolation produces a diurnal change in convectional friction which in turn produces a diurnal change in the conversion of the kinetic energy of the wind into static or elastic atmospheric pressure, and to this I have for many years past been accustomed to attribute a large part of the observed diurnal variation of the barometric pressure. A corresponding interchange of momentum and pressure also accompanies plane horizontal motion over smooth water and low-lying rough land or even rough water. The atmospheric motions disturb the rotating earth and probably contribute to the variation of astronomical latitude and longitude discovered by Dr. Chandler.

The atmospheric temperature, or more properly its heat energy or thermal content, is subject to a steady loss by radiation outward to space, by radiation downward to the land and water, and by the chemical changes involved in melting snow and ice, in evaporation, and in the growth of plants and animals. The details of all this are complex and often obscure, but in general the thermal energy present in the atmosphere, or the excess of insolation over radiation, maintains a fairly steady condition of movement in the atmosphere for any given day of the year and probably, on the average, for a whole season or year. An excess of heat causes inequalities in this steady condition which, from the point of view of analytical mechanics, are represented by the large and small but always temporary evanescent whirls, cyclones, or whirlwinds that course over the globe. These whirls must be treated as an essential part of the circulation of the atmosphere, quite as much so as are the resistances introduced by the stationary features of the earth's surface and the floating irregularities introduced by the moving clouds. Some method in dynamics must be devised to study the influence of these moving clouds and whirls. They are to be considered as a consequence of and superposed upon the irregularities introduced by areas of snow, land, and water, and by the annual apparent movement of the sun from the southern Tropic of Capricorn on December 21 to the northern Tropic of Cancer on June 20 and back again.

Our problems can not be resolved by merely examining charts of the globe, charts of the diurnal insolation, or charts of the prevailing upper and lower temperatures, moistures, and pressures, or charts of the orographic resistances to the motion of the atmosphere. The methods most appropriate for attacking the problems are not those of types and averages, but those of analytical mechanics, and it is only after the problems have been fully stated analytically and algebraically that we are likely to succeed in devising auxiliary geometrical and graphical methods of solving them that may eventually be made the basis of a system easily handled by practical experts. Of course such a system never can become a "popular method" capable of being used by every citizen, as some would seem to expect. Meteorology, like astronomy, is passing from the hands of amateurs into those of special students who can devote a lifetime to the work of resolving her riddles. Although I shall only suggest modes of solution, yet it will not seem trite if I call attention to the formulæ that present the mechanical conditions that must be fulfilled by every particle of the earth's atmosphere. These need not seem abstruse or profound because they are clothed in the simple algebraic language that is used in order to give precision; the fundamental principles expressed by these formulæ are easily comprehended by all. In general, it is not the principles that underlie modern science, but the art of reasoning upon these principles so as to obtain correct results, that constitutes our great difficulty. The healthy human mind is adapted to the easy apprehension of a simple statement of facts or principles, but there are relatively few who are gifted with the special powers of logical intuition and argumentation needed in the simultaneous consideration of many principles. The most complex machine is merely a combination of simple elements. The beauty of geometry is exhibited in its simplicity. The complex atmospheric conditions to be considered in meteorology render its problems the most difficult of solution of all that occur in science.

I.

Historically speaking, the first of the fundamental laws to which the air was found to be subject was its expansion by heat as shown by Galileo's air thermoscope, and next came Boyle's law of elastic tension. Both combined constitute the law that expresses the possibility of the existence of a gas as distinguished from a liquid or solid; it is expressed by the equation of elastic pressure or the equation for the gaseous condition. The elastic pressure at any point in the atmosphere acts in all directions equally at that point. A unit mass of air will occupy a unit volume of space when it is subjected to a special temperature and pressure. A kilogram of ordinary pure dry air will occupy 1/1.29305 cubic meter of space when its temperature is 0° C., and when its elastic pressure is that of the so-called standard atmosphere, or that cor-

[3] See Annual Report of Chief Signal Officer. 1889. Part II. Preparatory studies for deductive methods.

[4] Perhaps the losses by east winds and by west winds counterbalance each other, so that there is no appreciable residual influence on the speed of the rotation of the solid earth itself.

responding to the weight of a column of mercury 760 millimeters high, having a temperature 0° C. and pulled downward by the normal force of gravity at sea level and latitude 45°, where $g_0 = 980$ centimeters per second. For any other pressure, p, and temperature, t, on the centigrade scale (or T on the absolute scale, $T = 273°$ C. $+ t$) this volume will vary as is expressed by the formula—

$$pv = RT \text{ or } v = \frac{RT}{p}. \quad \text{Or } \frac{1}{v} = \text{density} = \frac{p}{RT} = \sigma.$$

The constant $R = 29.2713$ for ordinary pure dry air, and 47.060 for aqueous vapor. The kilogram, the meter, and the centigrade degree are the fundamental units.

This equation merely expresses the laws of Boyle and Mariotte, Charles, and Gay Lussac, to the effect that every perfect gas expands in proportion to its absolute temperature and in inverse proportion to its elastic pressure.

For the ordinary atmospheric mixture of air and vapor the barometric pressure is the sum of the elastic pressures of all the components, and the density is the sum of the densities of the components.

The more complex equation deduced by Van der Waals, and confirmed by laboratory experiment, may be substituted for the above if considered necessary.

II.

The second condition to be enumerated is the hypsometric condition that the pressure of the atmosphere at any place depends on the weight of the superincumbent mass of air, except in so far as this pressure may be altered by the motions of the atmosphere. Hence, it ordinarily follows that each small change in altitude, which we call the differential of h, produces a differential change of pressure or a dp, such that—

$$dp = -\sigma g dh$$

where σ is the density and g the force of gravity prevailing in the layer of air whose vertical thickness is dh. This equation simply expresses the fact that the change in pressure dp is equal to the change in weight, or is equal to the weight of the thin layer whose thickness is dh.

On the right-hand side of this equation we have three variables, namely, the density, the force of gravity, and the variable altitude; but as the density depends upon both the temperature, the pressure, and the moisture of the air (and indeed upon its chemical constitution also, if as is very probable, there is a systematic change in the proportions of the various gases, as we ascend above the earth's surface) therefore, these varying quantities must be introduced in terms of their dependence upon the altitude (h) before this equation can be integrated. Under the simplest possible assumptions, Laplace performed this integration, and obtained the formula generally known as Laplace's hypsometric formula, expressing a relation between altitude, pressure, temperature, moisture, and gravity. A very complete study of this subject by Angot, published in the year 1898, shows that neither the simple assumptions used by Laplace, nor any others that are available, are likely to give results sufficiently accurate to be acceptable to future meteorology, although they may be reasonably useful when the barometer is used for approximately determing the height of mountains. The meteorologist must, for accurate work, not assume but observe the upper and lower temperatures and moistures by means of balloons and kites (rather than on mountain tops). The results of the best work that has hitherto been done, as recently published by Assmann and Berson, show that we have many surprises in store for us. More detailed and accurate explorations of the upper air must be made before we can with confidence express the relation between temperature (t), moisture (e), pressure (p), and altitude (h). Undoubtedly these relations vary with time (τ), i. e., the hour of the day and the day of the year, with the geographical latitude (β) and longitude (λ) of the place, and especially with the location of the place relative to the oceans and the continents. We must, therefore, express these relations by a general analytical formula, namely:

$$t = F^v \ (\lambda \beta h \tau)$$
$$e = F'' \ (\lambda \beta h \tau)$$
$$g = F''' \ (\lambda \beta h)$$

(a) As concerns gravity, although its changes are small, they are appreciable in studying the motions of the atmosphere, and when a proper gravity survey has been made over the continents and the oceans we shall obtain a satisfactory expression for the function F'''. At present Hellmann's is the best that we have.

(b) As regards the temperature, its irregular horizontal distribution over the actual surface of the earth must be reduced to an ideal sea level and expressed graphically by means of isotherms, after which these must be expressed algebraically by means of spherical harmonics. These functions were first applied to the distribution of terrestrial magnetism by Gauss, Weber, and Erman, and more recently used by Dr. G. W. Hill to express the distribution of the force of gravity at and above the earth's surface. Schoch has computed the coefficients of the terms that occur in the development of this function so as to satisfy 72 temperatures read off from Dove's isotherms for 1852. His formula reproduces the observed temperatures to within 1° Reaumur, and although the Reaumur scale is not now in use, yet I will quote the formula as given in Reaumur degrees in Dr. Frank Waldo's translation of the inaugural dissertation of Dr. Schoch:

φ = longitude from Greenwich.
θ = North polar distance = $90° - \beta$.
t = temperature in degrees Reaumur.

$$\begin{aligned} t = {} & 11.99° + 0.13° \cos\theta - 31.71° (\cos^2\theta - \tfrac{1}{3}) \\ & + \sin\theta \{ [0.38° + 2.66° \cos\theta] \cos\varphi \\ & + [0.23° - 0.50° \cos\theta + 0.29° (\cos^2\theta - \tfrac{1}{3})] \sin\varphi \} \\ & + \sin^2\theta \{ [0.23° + 2.49° \cos\theta] \cos 2\varphi \\ & + [0.38° - 1.40° \cos\theta] \sin 2\varphi \} \\ & - \sin^3\theta \{ 0.80° \cos 3\varphi \}. \end{aligned}$$

This equation therefore expresses that part of the function, F^v, that depends upon the latitude and longitude. The portion depending upon the altitude is still to be determined more accurately from observations with balloons and kites, but we may consider the adiabatic law of convective equilibrium as an excellent first approximation. The portion of the function, F^v, depending upon the time (τ) is of a double nature. Exterior to the earth we have a great source of heat, the sun, whose intrinsic radiation may be assumed to be constant or variable according as we follow one or the other authority in solar physics. It is probable that the variations rarely exceed 1 per cent, but even this would be an appreciable quantity in dynamic meteorology. As we do not wish to complicate our atmospheric problem unnecessarily, we may assume that the solar thermal constant is really constant during the day, month, or year that we may happen to be investigating and that its value lies somewhere between 3 and 4 calories; that is to say, that at the mean distance of the earth from the sun, a surface of 1 square centimeter exposed normally to the solar rays, and outside of the earth's atmosphere, will receive in one minute three or four of the absolute units of heat known as a small calorie, or the amount of heat required to warm a gram of water 1° C.

But although the solar radiation may be constant, yet the distribution of that radiation on the earth's surface or within the earth's atmosphere is by no means constant. The so-called insolation at any moment of time depends on the altitude of the sun above the horizon, and on the intrinsic

transparency of the atmosphere above the observer, taking into full consideration the effect of cloud, haze, and fog. It is this variable insolation that largely determines the temperature in any part of the atmosphere and that introduces the element of time into the function, F'; furthermore, the horizontal motions of the atmosphere, by carrying the heat to and fro, the ascending and descending motions by causing the cooling due to expansion and the warming due to compression, the formation of cloud and rain by causing new warm and cold spots, all introduce the element of time and a new set of inequalities in temperature and moisture as a result of motions that were themselves the result of the initial inequalities. Therefore, the temperature (t) and moisture (e) or the functions F' and F'' contain the time (τ) both directly and implicitly, so that the final functions represent the so-called dynamic equilibrium by reason of which the initial thermal irregularities are so modified as to form a new distribution of temperature, such that it shall be as nearly as possible consistent with what is called a steady system of motions in the atmosphere.

The distribution of direct insolation was long since investigated by Lambert, and in 1855 by L. W. Meech; an analysis of the subject, convenient for use in our dynamic equations, was given by Ferrel in his Professional Papers No. XIII and in his Researches and, subsequently, in another form by Angot who showed algebraically, numerically, and graphically the quantity of heat that must be received from the sun by a horizontal surface at various heights in the atmosphere, namely at the outer limit where the atmospheric absorption is zero, at a lower stage where the zenithal absorption is 0.1, and so on by tenths down to the surface where the absorption is 0.8. These tables are perfectly general and can be applied to any condition of the atmosphere at any time and place.

(c) We have spoken fully of the elements of the function, F', that represents the temperature. Similar remarks may be made with regard to moisture; the function, F'', must depend directly on the temperature, and the evaporation from the ocean, the lakes, the snow covered ground, the moist soil or vegetation, and must depend implicitly again on the winds. Concerning all of these details we have as yet relatively little satisfactory knowledge, and for the present we must be content to introduce the best approximations, or those that are most convenient for mathematical treatment.

(d) We now come to a physical question about which there is still much discussion, which of course illustrates again the uncertainty of our present knowledge. The solar radiation is a complex influence, and can produce electrical, thermal, optical, and chemical effects according to the nature of the substance on which it acts and the attendant conditions. A part of this radiation is absorbed long before it reaches the earth by what is known as the solar atmosphere. An appreciable part is absorbed by the gases and vapors that are undoubtedly present in the upper air. Notwithstanding this sifting process enough reaches the upper surface of the clouds, the ground, and the ocean to keep the atmosphere of the illuminated half of the earth in such a state of commotion by day that twelve hours of darkness can scarcely allay it. An exhaustive treatment of the effects of insolation on the atmosphere would require us to consider what becomes of each wave length or each group of waves that emanates from the sun. This leads us to the analysis of the sunbeam by means of the spectroscope, the bolometer, and other forms of apparatus such as the various sunshine recorders that measure in some cases a heating effect, in others a chemical effect produced by the sunshine. Our first attention must be given to the heating effect, as it is probable that over nine-tenths of the radiant solar energy produces heat in our atmosphere either by direct absorption by the air or by conduction, radiation, and convection from the earth after the earth's surface has absorbed it, or by conduction, radiation, and convection from the ocean after it has been absorbed by the ocean and is returned to the atmosphere in part as the latent heat of vapor of water. This class of problems admits of the most detailed study but may best be treated in a general statistical way. The latter alone is practicable for dynamic meteorologists, who will do well to follow very closely the path laid down by Dr. W. Zenker in his work, The Distribution of Heat on the Earth's Surface, Berlin, 1888, and The Thermal Basis of Climates, Halle, 1895. According to his figures, some of which will be recognized as based upon the old value of the coefficient of absorption of the unit thickness of the atmosphere, 0.778, we have the following table showing the total sum of the thermal effects of the rays absorbed directly by the atmosphere and absorbed after the diffuse reflection that goes on in the atmosphere and at the earth's surface.

The heat received by a horizontal unit surface in a unit time in terms of the normal unit of radiant heat outside the atmosphere (from Zenker's Distribution of Heat).

Z. D. of the sun.	Surface outside the atmosphere.	Surface below the atmosphere.	Absorbed by atmosphere.	Absorbed by earth.	Absorbed by sea.	Absorbed by snow.
°						
0	1.0000	0.778	0.222	0.9280	0.8955	0.7715
10	0.9848	0.759	0.226	0.9117	0.8790	0.7577
20	0.9397	0.716	0.244	0.8665	0.8350	0.7201
30	0.8660	0.646	0.220	0.7918	0.7616	0.6583
40	0.7600	0.553	0.213	0.6911	0.6618	0.5743
50	0.6428	0.440	0.203	0.5683	0.5387	0.4723
60	0.5000	0.310	0.190	0.4237	0.3923	0.3521
70	0.3420	0.175	0.167	0.2683	0.2351	0.2230
80	0.1736	0.054	0.120	0.1110	0.0850	0.0914
90	0.0000	0.000	0.000	0.0000	0.0000	0.0000

From these fundamental figures Zenker computes the distribution of insolation for any part of the earth's surface, for a mean solar day and for the whole year, over the land, the ocean, and the snow covered surfaces, but into these details we do not now need to enter further.

(e) Besides this direct insolation our terrestrial temperatures are also affected by the reflected solar rays, reflected not only from visible surfaces on the earth and from the larger particles that form clouds, but also from the invisible particles of aqueous vapor and dust that float throughout the atmosphere. These exert a selective reflection; the finest vapors and perhaps even the molecules of the gaseous components according to Rayleigh send us the blue sky light, but the larger particles send us also the longer waves of heat or the warm portions of the spectrum. When the sky is of a deep blue tint the air is dry and comparatively little heat is reflected to us by the atmosphere, but when a haze overspreads us, and is formed of small particles not too far apart, it reflects a very considerable amount of heat to the observer as a sum total of that sent from the whole apparent hemisphere of air above him. The amount and quality of this diffuse reflection has been studied by Wiener, Homén, and others in papers recently published. By utilizing these works we are now in a position to cover the globe with lines of equal insolation on which we build lines of equal absorption of heat by the earth's surface, whence follow lines of equal heating, of equal radiation outwards, and of equal temperature effect on the atmosphere and the globe so far as the initiative thermal action of the sun is concerned.

III.

There is another thermal condition to be considered, namely, the air must obey the laws of thermodynamics; in other words, the molecular energy contained within a mass of air is equal to the sum of its sensible heat and its latent heat, and in atmospheric processes the energy of the molecules is

frequently transformed, at least in part, into the energy of the whole mass or vice versa. When a quantity of heat, dQ, is added to or taken from a mass of free air, there may result changes of temperature or changes of volume, also evaporation or condensation of the vapor; if the air is confined in any way as by friction there may also be changes of pressure. The energy is not destroyed but is manifested in other ways. This law of the conservation of energy is the basis of the following fundamental equation in thermodynamics, which expresses the fact that an increase of temperature, dt, can be produced by the quantity of heat expressed by Cdt, and again that an increase of volume, dv, which means a little internal and much external work, can be produced by the quantity of heat, $Apdv$, and that if we add together these two quantities we get the total quantity of heat that is communicated to the mass of air. This thermodynamic condition is expressed in the following equation:

$$dQ = C_v dt + ART\,dv/v = C_v dt + A\,pdv$$

In general, therefore, this equation expresses in exact terms the principle that any change in the quantity of heat in a mass of air, whether caused by sunshine, by radiation, absorption, or conduction, or by any other process, must produce changes in temperature or volume, or both, that are related to each other by the condition thus algebraically expressed.

In addition to the operations by which heat is manifestly communicated to the air from the hot surface of the ground, or given up by the air to the ground and to outer space by radiation, there is another very important but more insidious source of heat. By evaporation from the surface of the moist land and leaves of plants, and especially from the surface of the lakes and oceans, the atmosphere receives an amount of moisture that must be on the average equivalent annually to the normal total snowfall and rainfall of the earth. In the equatorial regions this moisture enters the atmosphere at a temperature of 20° C. or higher, but in the polar regions it enters the atmosphere at temperatures that may be below freezing. Now the latent heat of melting and of evaporation and the specific heat of aqueous vapor are so large that the layer of water, averaging 3 feet in depth over the whole globe, that is thus annually added to and extracted from the atmosphere represents a transfer, an increase, and a subsequent loss of an immense quantity of heat. Wherever this invisible vapor is condensed into cloud, rain, hail, or snow a corresponding amount of latent heat becomes sensible, the air is locally warmed, and rapid motions take place in the atmosphere. This sensible heat is eventually lost by radiation, but, generally speaking, not before it has had a powerful influence on the motions of the atmosphere; indeed, it is the addition, the presence, and the loss of this heat, which is first latent and then sensible, that initiates most of our weather phenomena. The evaporation of water and the condensation of aqueous vapor must be considered as methods of adding heat to the air; on the other hand, evaporation of cloud, etc., cools the air; and these operations must proceed in accordance with the thermodynamic law above expressed.

In many cases atmospheric processes go on so quickly (as when air is rising rapidly, and especially in the interior of a cloud, where there can be no considerable radiation) that a given quantity of moist air retains practically all its heat while going through the process of formation of cloud and the subsequent dissipation of that cloud; if some is lost by radiation and some by the fall of rain, snow, or hail from the cloud to the ground, yet what occurs in an hour or a day can represent only a small percentage of the whole. Those physical changes or processes among molecules of matter that do not involve any change in the quantity of heat are called adiabatic. In these cases the dQ of our equation is zero. The discussion of the adiabatic changes of temperature, moisture, volume, and altitude in a mass of moist air has been rendered quite simple by the graphic construction invented by Hertz and improved of late by Professor von Bezold and his pupil Dr. Otto Neuhoff. The problems may also be solved numerically, and perhaps more accurately but scarcely so perspicuously, by means of the extensive numerical tables prepared by our colleague, Professor Bigelow, and published in his report of International Cloud Observations, Annual Report Chief of the Weather Bureau, 1898–1999, Vol. II. From these tables or from the adiabatic diagrams we learn the temperature, moisture, and other conditions through which a given mass of air must pass when it is in motion, either horizontally or vertically, from any region to another in which different pressures prevail.

IV.

We now come to consider another condition that the whole atmosphere, as well as any portion of it, must fulfill when in motion. Owing to the fact that the air is almost perfectly elastic, and that it expands very rapidly into any adjacent empty space, it is impossible under ordinary meteorological conditions to make or maintain a vacuous space within the atmosphere. Again when a portion of the atmosphere is in motion the adjacent portions affected by this, and even distant portions, must have corresponding motions. Putting these two considerations together we say that the *motions* that may prevail throughout the atmosphere must be considered as continuous, just as we consider the *mass* of the atmosphere as continuous; that is to say, there are no breaks or gaps in the mass and no sudden independent arbitrary changes of motion. So far as the continuity of motion or velocity is concerned, it is expressed by the sign of integration, by the process or method of accomplishing this, and by the assumptions that are implied therein. So far as the continuity of mass is concerned, this condition is expressed by the so-called equation of continuity, which simply says that if the density of a fluid is uniform, then as much matter must go into a given space as flows out of it, or if the fluid is an elastic gas, then the change of density is the excess of gas crowding into a given space over the deficit made by the outflow from that space. If ρ is the density, τ the time, u, v, and w the velocities of motion of any particle in the direction of positive x, y, z, respectively, then the condition of continuity as to mass may be expressed by the following equation of partial differentials:

$$\frac{\partial \rho}{\partial \tau} + \frac{\partial (\rho u)}{\partial x} + \frac{\partial (\rho v)}{\partial y} + \frac{\partial (\rho w)}{\partial z} = 0$$

which equation simply says that at any point the rate of change of density with time is opposite to the changes in the products of the density by the three component velocities; or an increase in velocity diminishes the density.

V.

The law of the conservation of energy imposes another general condition on atmospheric phenomena. All motions and mechanical phenomena originating in the atmosphere, whether massive or molecular, must be consistent with the principle that the sum total of the kinetic energy, E_t, the potential energy, E_v, and the intrinsic energy, E_w, must be constant, or if the sum total changes with time (as, for instance, if possibly the sun changes his radiation and our insolation or supply of energy) then the law of such changes must be given explicitly as one of the conditions of the problem. The conversion from mass energy to molecular energy, or the giving up of either molecular or mass energy by the atmosphere

to the mass of the globe, or the loss by radiation of molecular energy that may just previously have been mass energy is all represented by a so-called dissipation function, F. If for any given boundary surface, S, we draw a normal inwardly into the atmosphere and this normal makes such angles with the coordinate axes that l, m, n are the respective cosines, u, v, w being the component velocities, and p the elastic pressure, then this equation of conservation of energy may be written as follows:

$$\frac{\partial (E_t + E_v + E_w)}{\partial \tau} + 2F = \int\int p(lu + mv + nw)\, dS$$

VI.

We have now expressed first, the conditions relative to temperature, volume, and pressure, then the conditions that involve motion and continuity of motion, mass, and energy; but a most important condition still remains, namely, the relation that must subsist between the pressure and the motion, or rather the momentum and the energy. Motion must be considered as the result of pressure, each particle of the atmosphere sustaining a pressure due primarily to the weight of all above it. The force of gravitation, the additions of heat and moisture, the centrifugal force due to the rotation with the earth and the resistances of its surface may be considered as the external forces acting on the atmosphere while the pressure at any spot is the internal force acting upon a local mass of air. These forces may produce either uniform or accelerated direct linear motions and they may also produce rotation on the part of the local masses of air. The general condition that for every motion produced by a force there must be an equal and opposite reaction is expressed by the following system of equations:

$$-\frac{\partial P}{\partial x} - \frac{1}{\sigma}\frac{\partial p}{\partial x} = \frac{\partial u}{\partial \tau} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} + w\frac{\partial u}{\partial z} - \mu\left[\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2}\right]$$

$$-\frac{\partial P}{\partial y} - \frac{1}{\sigma}\frac{\partial p}{\partial y} = \frac{\partial v}{\partial \tau} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} + w\frac{\partial v}{\partial z} - \mu\left[\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2} + \frac{\partial^2 v}{\partial z^2}\right]$$

$$-\frac{\partial P}{\partial z} - \frac{1}{\sigma}\frac{\partial p}{\partial z} = \frac{\partial w}{\partial \tau} + u\frac{\partial w}{\partial x} + v\frac{\partial w}{\partial y} + \frac{\partial w}{\partial z} - \mu\left[\frac{\partial^2 w}{\partial x^2} + \frac{\partial^2 w}{\partial y^2} + \frac{\partial^2 w}{\partial z^2}\right]$$

in which the left-hand terms present the action of the external forces, P, and the internal pressure, p, upon a unit volume of air whose variable density is σ. On the right-hand side, the first four terms express the fact that the change of force or pressure along a given axis of x or y or z, as expressed on the left hand, may produce changes in velocity along all three of the axes as well as independently along that axis itself. The last three terms, or those within the brackets that are multiplied by μ, express the retarding effect of the viscosity or internal friction, μ, that is small but appreciable in all gasses at ordinary temperatures. The terms depending on viscosity would have no influence if all the motions were absolutely uniform throughout the mass, that is to say if the second partial differentials of the velocities with respect to the coordinates of the point (x, y, z) were zero.

The effect of all the various forms of resistance and friction between the atmosphere and the earth, before described, does not enter explicitly into these equations, but must be considered in connection with the boundary conditions and initial conditions after the first integration has been effected. Owing to the irregularity of the resistances of the earth's surface, a perfect integration would inevitably necessitate the use of complex functions; approximate solutions may be found by using spherical functions or graphic methods instead of analysis, but for a first approximation we may simply introduce the conception of the rough land and smooth water hemispheres, as we did in regard to the distribution of heat and moisture. If we neglect ordinary viscosity and sliding friction, we must at least not neglect convectional resistances and must introduce these latter as functions of the vertical distribution of temperature, since this determines the ascending and descending vertical currents that produce the mixture of slow and rapid horizontal currents whence result their mutual resistances or interferences and the conversion of kinetic into potential energy. The extent of the diurnal barometric variation, $\pm$ 0.10 inch, as compared with the depth of air affected, shows the importance of this item relative to the total energy of the wind. The convectional resistance due to mixtures produced by impact of currents against continents and mountains are of less importance and do not depend on vertical temperature gradients.

VII.

It is to be expected that long before we have attained to what may be called a complete solution of all these equations of condition we shall by means of general theorems have at least obtained some approximately correct ideas concerning the general mechanics of the atmosphere. Already many have proposed to skip this long process of reasoning and substitute for each locality and for the prospective rigorous solutions some approximate sine and cosine formula, as though it were certain that the Bessel-Fourier series or some other combination of periodicities would satisfactorily represent the motions and other phenomena of the atmosphere. But the problem is undoubtedly too complex for plane harmonics; we shall need to develop the original functions and integrals in a series of spherical harmonics or equivalent equations in which latitude, longitude, and altitude must play equal parts. A first step in this direction was taken by Oberbeck, who adopted a few terms of the harmonic series, but a second equally important step was taken by Margules, who, assuming a simple distribution of temperature over the earth's surface, worked out a system of tesseræ, dividing the globe up into regions of low pressure and high pressure with the attending winds. A more exact adherence to actual temperatures and especially a more complete consideration of the orographic resistances of the earth's surface will undoubtedly lead to more complex results.

The question as to whether there can be any long continued important natural periods as distinguished from forced periods in atmospheric phenomena, has been discussed by Herrmann in the Bulletin of the American Mathematical Society for June, 1896. Starting with an assumed initial temperature and a rate of revolution corresponding to any initial state of equilibrium, Herrmann shows that, in general, the atmosphere can not settle down to a new state of equilibrium except it be one of motion and dynamic equilibrium. There must be an interchange, not only between the poles and the equator but between the east and west. Then the question recurs, can these internal movements become perfectly steady or be so adjusted to each other and to external conditions that each system remains invariable within any given zone of latitude. Hermann concludes that steady motions and stationary pressures can not exist in an atmosphere covering a homogeneous globe, and presumably the same result must follow for the actual, irregular globe. The motions of the real atmosphere must consist of irregularities and periodic oscillations superimposed upon more uniform regular progressions, but never repeating themselves. It also follows that the indiscriminate monthly and annual averages,

useful in climatology, are quite inappropriate and misleading from a dynamic point of view. Another phase of the same problem is found in the question: can simple seasonal variations in atmospheric pressure and wind be forced to exist by reason of regular seasonal variations in the temperature due, for example, to periodic variations of the solar constant, or to any other influence outside of the atmosphere? We infer that this also is not possible for a globe and atmosphere of the existing dimensions and physical properties, but might be for a much deeper atmosphere.

It would seem, therefore, that long-range predictions can best be carried on quite independent of any simple system of strictly periodic functions.

VIII.

So far as the prediction of rain is concerned, we still have to recall the fact that rains are due in some way or other to the rather rapid ascent of warm, moist air. In some cases, like the Indian monsoon rains, the air is forced to rise up by its attempt to pass over a mountain range. The analytical study of this problem has just recently been attempted by Prof. Dr. F. Pockels of the University of Heidelberg, whose memoir was published in the MONTHLY WEATHER REVIEW for April, 1901, with added notes in the REVIEW for July, 1901.

Professor Pockels has worked out an analytical solution of the equations of motion combined with those of thermodynamics for the case of a horizontal, deep stratum of moist air of uniform temperature and humidity, forced to ascend a mountain slope whose curvature can be represented by a simple sine and cosine formula. He shows the amount of precipitation that must occur (of course in the form of cloud) at each step of its ascent, and that within a given volume of moist air the greatest density of cloudy precipitation will occur in many cases before that volume has reached the highest point in its ascending path. He also shows that in many cases an upper stratum of air in the general moving mass will rise sufficiently to form condensation before the lowest stratum can do so. Pockels does not attempt to distinguish between the original cloudy condensation and the subsequent precipitation, as rain or snow, but assumes that in general they must be in proportion to each other. Of course it is well understood that the actual rainfall is but a small percentage of the total cloudy condensation. The course of reasoning that Pockels has carried out analytically can doubtless be expressed geometrically or graphically, as also by the method of numerical quadratures. He has therefore contributed greatly to the development of the whole series of approximate integrations that must be relied upon when we attempt to build up a systematic deductive treatment of our problems. His work shows that if by any process we can determine for a long time ahead what the temperature, moisture, and wind will be over a given region, we may then hope to attempt for that region a long-range prophecy of the rainfall. But he particularly calls attention to the fact that in making such use of his method one must not rely upon the simple average temperature, moisture, and wind, since if these vary considerably during the time under consideration, as they naturally do, then the most favorable conditions may give rain when the average conditions will not do so. In other words, the formation of cloud and rain is a discontinuous process, occurring and stopping at certain limiting conditions, and it is only the favorable conditions that we really need to consider. This important principle simplifies rather than complicates our problem, for all the ultimate phenomena in meteorology have this same sort of discontinuity, due to their intermittent character. For instance, the air does not always move in simple, smooth curves, but often stops and whirls around until a certain excess of energy has been consumed and then goes forward for a time, until by reason of differential resistances or a new access of energy it is again in condition for another set of whirls; and so it goes on over and over, whirling when the moment of the push forward exceeds the moment of resistance or when the moment of rotation exceeds the moment of friction, but running along smoothly when it is less than the moment of friction. Closely analogous cases are presented in the two modes of flow of water through a tube, so skilfully shown experimentally by Osborne Reynolds, or in the lamellar flow of air between two horizontal plates, investigated analytically by Lord Kelvin. In fact, the movements of the lower atmosphere on a small scale and the movements of the whole atmosphere, when we take a comprehensive view of it, offer grand applications of the laws of turbulent and of tumultuous movement, developed by Boussinesq in his study of the theory of the flow of water in rivers and canals. (See my "Preliminary Studies for Deductive Methods in Meteorology," Report Chief Signal Officer, 1889.)

IX.

The initial conditions prevailing in the upper and lower air at any time offer a most important observational source of uncertainty in beginning our proposed long-range forecasts. The equations that have been given in the preceding paragraphs imply that we know the conditions prevailing overhead as accurately as we do those at the surface of the earth. But this of course is not and may never be the case. One might have hoped that long continued records from mountain tops, and the numerous balloon ascensions of the last century, might have given us some basis for conclusions as to the conditions prevailing a few miles above sea level. But the more careful recent work with self-recording apparatus, and especially that with the so-called sounding balloons, has shown that at least in Europe, conditions prevail at great heights that were wholly unexpected. The newer observations are in fact found to be nearly accordant with those indicated by theoretical thermodynamics and hydrodynamics, and it is believed that all the older observations, which gave results contrary to mechanical theory, were really affected by very large errors of observation. The newest results of observation and theory are fully set forth in a recent work by Assmann and Berson, Ergebnisse, etc., Results of Observations of Scientific Balloon Voyages, Berlin, 1900, in three volumes, large quarto. This work shows that there is quite as great a diversity in temperature and moisture, and perhaps also in pressure, ten miles above sea level as there is at the earth's surface. Until quite recently the tendency had been to assume that above the so-called "lower" air there exists a layer embracing quite an appreciable part of the atmosphere in which temperature, moisture, and the chemical or gaseous constituents, as also the dust, are all quite uniform and subject to slight changes, if any. But at present we are forced to recognize the presence of great variations of temperature, and even of a very considerable atmosphere of new gases that are unimportant in the lower atmosphere, as also the occasional presence of dust, meteoric dust, or volcanic ejecta, which may have a very great influence on the local air temperatures, because they absorb solar radiation by daytime and warm up the adjacent air by convection, but also radiate rapidly, and, therefore, at night cool the adjacent air by conduction. Woodward maintains that the tidal action of the sun and moon on this upper atmosphere, which is more like a ring of discrete particles than a gas, may produce appreciable periods in the meteorology of the lower air. I can but anticipate that in addition to the use of sounding balloons and kites, we may get some idea of the general condition of the air, or at least the lower $\frac{9}{10}$ of it, by observations of the scin-

tillation of the stars, of the blueness and polarization of the sky light, of the intensity of special dark bands seen in the solar spectrum, or of cold bands observed with the bolometer, or again, by determining the general diathermancy of the atmosphere by means of Angström's, or some other form of, pyrheliometer.

X.

Although our direct observations of upper atmospheric conditions in general are limited and imperfect, yet it happens that much may be accomplished whenever we are able to demonstrate the ascent of a mass of air to the upper regions and its descent to the surface in some distant part of the globe. In such cases we may know quite closely the initial surface conditions, and can therefore, by thermodynamics, calculate the intermediate and final conditions of the descending mass, no matter how high it has ascended above the ground. Unless it has been subjected to some influence external to the earth, we ought to be able to quite exactly foresee its condition when it returns to the surface. In such calculations the most difficult problem is to determine, or even to estimate, the change that takes place in the ascending mass of moist air (1) by virtue of the fall of rain or snow carrying both matter and heat out of the original air down to the ground and (2) by virtue of the radiation of heat from the gases, aqueous vapor, dust, and, especially, the liquid cloud particles or the solid ice crystals of the snowflakes. At the present time, indeed, we understand the first of these changes, but the second class can only be crudely estimated; they can not even be measured directly, but the accuracy of our estimates can be tested by the observed condition of the air before and after it descends to the ground. The average coefficient of radiation of dusty, moist air was first determined by Maurer.

As the formation of clouds is a fundamental phenomenon, affecting the motions of the atmosphere, on the one hand, and a necessary precedent to rain, on the other, therefore the long-range forecaster must consider the theorems worked out by Brillouin in his recent memoir, Vents Contigus, etc., or the Action of Contiguous Currents of Wind and the Mixture of Air in Forming Clouds. It is well recognized that such clouds of mixture give but little rain and are rarely of importance to the agriculturist or hydraulic engineer. Therefore they do not directly enter into a long-range forecast of rainy seasons in their own locality; but, in so far as they form extensive layers, they screen the earth from the warmth of the sun and from the coolness due to outward radiation, and therefore may have a very important influence on the distribution of heat in the atmosphere, and therefore on the currents of air, and eventually on the rainfall itself in some distant region.

XI.

But when all that can be has been done to ascertain or determine the distribution of temperature or moisture in the atmosphere, there still exists the fundamental mathematical difficulty of our problem in the introduction of all this meteorological data into the equations of pressure and motion or energy given above in Section VI (on page 558) and the integration that must then necessarily be executed. Since we are dealing with the globe as a whole, we must convert these equations into those for polar or spherical coordinates, as was elegantly done by J. Cottier, MONTHLY WEATHER REVIEW, July, 1897. In the process of integration there is scarcely any term or force that can be neglected in general, although some may be negligible in special cases. Rigorous investigations are of course not to be thought of; the equations must be developed into series, as is done in the lunar theory and other complex astronomical problems, and the attention must first be concentrated upon the computation and tabulation of the important terms of the series.

Perhaps the most radical method of simplifying the problem and at the same time doing approximate justice to the influence of the reaction upon each other of the aqueous and continental hemispheres of the earth, is to substitute for the observed temperature, moisture, and pressure, not a development by spherical harmonic functions, but a general system of isoabnormals symmetrical about the north pole of the land hemisphere and the south pole of the water hemisphere, locating these poles respectively at longitude 0° and north polar distance 38°, and at longitude 180° north polar distance 142°, thus making Greenwich both the meteorological and the orographic north pole. This will minimize the influence of South Africa and South America in the Southern Hemisphere, and it will give us a resulting system of winds representing fairly well the Asiatic southwest monsoon of summer and northeast monsoon of winter; it will show, for instance, that the air carried from the southern Indian Ocean into the Northern Hemisphere east of Asia in June and July must descend within the arctic circle and flow out of that eventually during the subsequent winter over North America. This flow will be found to be not a so-called steady movement, but one subject to great oscillations, east and west, from month to month; it explains the elliptical upper isobars shown in the MONTHLY WEATHER REVIEW, December, 1895, and November, 1896, Chart VII; also the climatic changes observed in India by J. Eliot, Quar. Jour. Roy. Met. Soc., January 18, 1896; the Variations in Storm Tracks, etc. The general circulation tends to obey the law laid down by Ferrel for the currents over a globe that is perfectly frictionless and on which the lines of temperature, moisture, and pressure are symmetrical about the astronomical poles, namely, that all moments of inertia with reference to the earth's axis of rotation, which is also the atmospheric axis of equal density, must be symmetrical and must balance each other as to east-west and north-south motions. But in the case we are considering, of an unsymmetrical system of lines, this balance is produced, not by a careful adjustment of simple rectilinear or curvilinear motions and not by superposed movements, but by a combination of these with more complex systems of horizontal whirls, so that large oscillations are necessarily introduced. Here we find the general explanation of the recurring irregular variations in the climates, the seasons, and the annual mean average conditions over America and Europe, from what would otherwise be symmetrical, uniform, normal values. The influences of the Atlantic and the Pacific oceans on the continents immediately adjacent to them would be uniform from year to year were it not for the overpowering influence of the oscillations caused by this want of agreement between the geographic and meteorological poles or the geographical and meteorological equators.

This study has already in part, and will eventually in full, elucidate the connections that are sometimes temporary, at other times almost permanent, and in many cases reciprocally inverse, between the average condition of the seasons in distant parts of the globe. From the very earliest times the American colonists endeavored to elucidate the relations between the weather of the Atlantic States and that of Europe; the modern daily weather maps and monthly summaries show these relations to be distinctly due to the movement of the lower stratum of air, as when cold blizzards and high pressures move from northern Canada south to the Gulf of Mexico, or from northern Russia southwestward to the Mediterranean. John Eliot shows by the Indian monsoon charts that unusual rains on the east coast of Africa or in Madagascar, or even in the high mountains in the interior of Africa, are fol-

lowed by diminished rains in India. The researches of Russel (Director of the Observatory of Sydney) seem to show that the droughts in Australia are accompanied or followed by droughts in other portions of the world. The series of charts compiled by Hildebrandsson, and published partly in his Researches on the Centers of Action of the Atmosphere, show that even when we adopt the arbitrary division of the year into twelve months, and chart the monthly departures of pressure, temperature, and rainfall from the normal values for those months, there are certain broad generalizations that become possible, and which would doubtless be still more pronounced if more appropriate periods were adopted. Thus, the departures from pressure are greater in winter than in summer and increase from the Equator toward the poles The barometric variations in the Azores and in the neighborhood of Iceland are nearly always opposed to each other, and the curves for Siberia and Alaska are generally inverse to each other. The curves for Tahiti at the center of the South Pacific area of high pressure, and those for Tierra del Fuego in the southern temperate zone are inverse. Among all these changes there appears, as yet, no law of successive transformations. By plotting the barometric departures on charts of the world, Hildebrandsson finds that the pressure is sometimes abnormally high over the arctic region but low over the equatorial region, or vice versa; at one time it is high over northern Europe but low over the arctic and North America; at another time it is low there and high here; during one month it is high over the arctic and low over the antarctic, and another month just the reverse.

The continuous set of daily maps of the Northern Hemisphere prepared by the United States Weather Bureau from 1875 to 1895, and actually published for nine years, have often given us abundant illustrations of the fact that the phenomena occurring in one part of the atmosphere are certain to affect other distant portions a few months later, and, in fact, may continue to be felt even for years. If we recall the observed movement of the vapor and dust ejected from Krakatoa in 1883 (its spread at great elevations near the Equator, moving westward around the world in a few days and its very slow spread northward, reaching latitude 40° north in nine months and 60° north in eighteen months), we shall the more easily understand that even greater events than this (such as those that produced the droughts of 1896 and 1899 in India), when once they occur, must propagate their influences also slowly, but not necessarily in precisely the same direction or manner. If there be a variation in solar radiation, it must affect the land and water hemispheres differently; our system of isotherms and isostats, that we have idealized into curves symmetrical about the orographic and meteorological axis of the globe, will be changed primarily as to intensity, and perhaps eventually as to location, and the general effect of solar variations on local climate will thus become distinguishable.

By thus considering the land and water hemispheres of our globe as the thermal and frictional disturbers of the phenomena that would otherwise pertain to a uniform surface, rapidly rotating and warmed symmetrically with reference to the north and south poles, and by introducing convectional resistances instead of viscosity, we seem able to take another step forward in meteorology and long-range forecasting.

It is only by the study of these general phenomena and their elucidation by the help of the laws of mechanics that we can expect to realize satisfactory long-range seasonal forecasts. We shall arrive at the desired result sooner and better by the study of the mechanics of the atmosphere than by the search for elusive empiric periodicities, and it is in the hopes of inducing some to turn their attention toward this study that I have submitted these views.

RECENT PAPERS BEARING ON METEOROLOGY.

W. F. R. PHILLIPS, in charge of Library, etc.

The subjoined titles have been selected from the contents of the periodicals and serials recently received in the library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau:

American Journal of Science. New Haven. Vol. 12.
Barus, C. Effect of Temperature and of Moisture on the Emanation of Phosphorus, and on a Distinction in the Behavior of Nuclei and of Ions. Pp. 327–347.
The Astrophysical Journal. Chicago. Vol. 14.
Pickering, E. C. Spectrum of Lightning. Pp. 367–369.
Journal of the Western Society of Engineers. Chicago. Vol. 6.
Wright, Wilbur. Some Aeronautical Experiments. Pp. 489–511.
Nature. London. Vol. 65.
Shaw, W. N. Meteorological Work for Science Schools. P. 128.
—— The "Armorl" Electro-Capillary Relay. Pp. 129–130.
—— Fresh Light on the Antarctic. Pp. 153–155.
—— The Inert Constituents of the Atmosphere. Pp. 161–164.
Smith, D. T. Relative Velocity in Streams. P. 174.
Science. New York. Vol. 14.
Ward, R. DeC. Hail Prevention by Cannonading. [Abstract of article by Friedrich Stengel.] P. 938.
Ward, R. DeC. The Dust Storm of March, 1901, and Glacial Studies. [Abstract of article by Richter.] P. 938.
Ward, R. DeC. The Climatic Control of Government in the Tropics. [Abstract of article by Alleyne Ireland.] P. 938.
Ward, R. DeC. Underground Temperature at Oxford. [Review of article published by Radcliffe Observatory.] P. 938.
Ward, R. DeC. Lehrbuch der Meteorologie. Von Dr. Julius Hann. Pp. 966–967.
Upton, Winslow. Physiological Effect of Diminished Air Pressure. Pp. 1012–1013.
Rotch, A. Lawrence. The Measurement of Wind at Sea. Vol. 15. Pp. 72–73.
London, Edinburg, and Dublin Philosophical Magazine. 6th series. Vol. 2.
Jeans, J. H. and Newton, Isaac. The Theoretical Evaluation of the Ratio of the Specific Heats of a Gas. Pp. 638–651.
Popular Science Monthly. Lancaster. Vol. 60.
Cox, John. Comets' Tails, the Corona and the Aurora Borealis. Pp. 265–279.
Proceedings of the Royal Institution of Great Britain. London. Vol. 16.
Rayleigh, Lord. Flight. Pp. 233–234.
Marconi, G. Wireless Telegraphy. Pp. 247–257.
Dewar, J. Solid Hydrogen. Pp. 473–480.
Scientific American. New York. Vol. 85.
Collins, Frederick. The Slaby-Arco Portable Field Equipment for Wireless Telegraphy. Pp. 425–426.
Scientific American Supplement. New York. Vol. 52.
Rotch, A Lawrence. The Use of Kites to obtain Meteorological Observations. Pp. 21718–21720.
Symons's Meteorological Magazine. London. Vol. 36.
—— Hann's Text-Book on Meteorology. Pp. 177–179.
—— Rainfall and Storms in November. Pp. 179–181.
—— The Moon and Rainfall. Pp. 183–184.
—— Weather and the Horns of the Moon. Pp. 184–185.
Terrestrial Magnetism and Atmospheric Electricity. Baltimore. Vol. 6.
Borgen, C. Report on the Magnetic Observations made during the Total Solar Eclipse May 17–18, 1901, at the Magnetic Observatory, Wilhelmshaven, Germany. Pp. 167–168.
Eschenhagen, Max. Report on the Magnetic Observations made during the Total Solar Eclipse, May 17–18, 1901, at the Magnetic Observatory, Potsdam, Germany. Pp. 169–172.
Fraser, H. A. Denholm. Report on the Magnetic Observations made at Dehra Dun, India, during the Total Solar Eclipse of May 17–18, 1901. Pp. 173–176.
Moidrey, J. de. Report on the Magnetic Observations made at the Magnetic Observatory at Zi-Ka-Wei, China, during the Total Solar Eclipse of May 17–18, 1901. Pp. 177–178.
Farr, Coleridge. Report on the Magnetic Observations made in Christchurch, New Zealand, during the Total Solar Eclipse, May 17–18, 1901. Pp. 179–180.
Hosmer, G. L. Report on the Observations of Magnetic Declination made at Sawah Loento, Sumatra, during Total Eclipse of May 17–18, 1901, by the party of the Massachusetts Institute of Technology, Boston. Pp. 181–183.
Claxton, T. F. Report on the Magnetic Observations made dur-

ing the Total Solar Eclipse, May 17–18, 1901, at the Royal Alfred Observatory, Mauritius Island. Pp. 184–185.

Moidrey, J. de. Magnetic Observations in Southeast China. Pp. 186.

Hazard, D. L. The Central Physical Observatory of Russia. Pp. 193–194.

Annuaire de la Société Météorologique de France. Paris. 49me Année.

Cœurdevache, P. Contribution à l'étude de la variation diurne de la vitesse du vent. Pp. 243–244.

Coeurdevache, P. Variations des éléments météorologiques au Pic du Midi. Pp. 244–246.

Demtchinsky, N. A propos de l'influence de la lune sur l'état barométrique de l'atmosphère. Pp. 246–249.

Cheux, —. Observations faites à l'Observatoire de la Baumette (près Angers), sur l'arrivée de plusieurs oiseaux. Pp. 250.

Maillet, Ed. Sur la prévision des crues à Pommeuse et à Coulommiers (Bassin du Grand-Morrin), à l'aide des hauteurs de pluie. Pp. 275–283.

Archives des Sciences Physiques et Naturelles. Genève. Tome 12.

Birkeland, Kr. Résultats des recherches magnétiques faites par l'expédition norvégienne de 1899–1900 pour l'étude des aurores boréales. Pp. 565–587.

Gautier, R. Observations météorologiques faites aux fortifications de Saint-Maurice pendant l'année 1900. Pp. 587–602.

Ciel et Terre. Bruxelles. 22me année.

Plumandon, J. R. Troisième Congrès international de défense contre la grêle. Pp. 458–471.

Prinz, W. Utilisation du stéréoscope en météorologie et en astronomie. Pp. 472–474.

—— La foudre en boule. Pp. 479–480.

Thoulet, J. La transparence et la couleur de la mer. Pp. 481–492.

Raulin, V. Les variations séculaires du magnétisme terrestre. Pp. 492–495.

—— Répartition de la pluie avec l'altitude en Angleterre. P. 503.

—— Les méfaits de la foudre aux États-Unis pendant l'année 1899. P. 503.

—— Sur la conservation de la radiation solaire. Pp. 503–504.

Van der Linder, E. La prévision du temps pour plusieurs jours. P. 504.

Comptes Rendus de l'Académie des Sciences. Paris. Tome 133.

Pellat, Henri. Méthode permettant d'évaluer en valeur absolue les très basses températures. Pp. 921–924.

Vallot, J. Sur les modifications que subit l'hémoglobine du sang sous l'influence de la dépression atmosphérique. Pp. 947–949.

Tissot, J. et Hallion, —. Les phénomènes physiques et chimiques de la respiration à différentes altitudes, pendant une ascension en ballon. Pp. 949–951.

Compan, P. Pouvoir refroidissant et conductibilité de l'air. Pp. 1202–1204.

Tissot, J. et Hallion, —. Les gaz du sang à différentes altitudes, pendant une ascension en ballon. Pp. 1036–1038.

Journal de Physique. Paris. 3me série. Tome 10.

Bouty, E. Expérience pour démontrer le décroissement de la pression atmosphérique avec l'altitude. P. 762. [Review of article by E. Salvioni.]

Bouty, E. Nouvel hygromètre. Pp. 762–763. [Review of article by E. Salvioni.]

Bouty, E. Sur la séparation des gaz les moins volatils de l'air atmosphérique et leurs spectres. P. 763. [Review of article by C. D. Liveing and J. Dewar.]

L'Aerophile. Paris. 9me Année.

Graffigny, Henry de. Une chaudière à vapeur d'ether. Pp. 235–237.

Salle, A. Automobilisme aérien. Pp. 238–239.

Farman, Maurice. Tourisme aérien. Pp. 244–245.

—— La photographie en ballon. P. 252.

La Géographie, Bulletin de la Société de Géographie. Paris. Année 1901. No. 12.

Rabot, Charles. Les variations du niveau des lacs et des precipitations atmospheriques dans l'Asie centrale. Pp. 473–474.

La Nature. Paris. 30me Année.

Plumandon, J. R. Troisième Congrès international de defense contre la grêle. Pp. 38–39.

Coupin, Henri. Acclimatisation de perroquets en Angleterre. P. 3.

Annalen der Hydrographie und Maritimen Meteorologie. Hamburg. 29 Jahrg.

—— Die Witterung zu Tsingtau im Juni, Juli, und August 1901. Pp. 554–556.

Grossmann, —. Die Aenderung der Temperatur von Tag zu Tag an der deutschen Küste in den Jahren 1890 bis 1899. Pp. 573–583.

Annalen der Physik. Leipzig. Vierte Folge. Band 6.

Lehmann, O. Ueber Elektrisirung der Luft durch Glimmentladung. Pp. 661–681.

Das Wetter. Berlin. 18 Jahrg.

Boernstein, R. Der Brandenburgische Witterungsdienst im Sommer 1901. Pp. 265–270.

Klengel, Friedrich. Ueber das Wetterschiessgebiet bei Windisch-Feistritz im südlichen Steiermark. Pp. 270–276.

Hennig, Richard. Extreme Witterungs-Erscheinungen. Pp. 276–281.

Gaea. Leipzig. 38 Jahrg.

—— Experimental-Untersuchungen über die Wärmestrahlung der Atmosphäre. Pp. 55–56.

—— Ueber die tiefste Temperatur, welche Insekten lebend überdauern können. Pp. 59–60.

K[lein J.] Witterungsdepeschen aus Island. P. 62–63.

Boletin del Instituto Fisico-Geografico de Costa Rica. San José de Costa Rica. Año 1.

Kumpel, Juan. La sombra en los cafetales considerada especialmente bajo las condiciones locales de terreno y clima de Costa Rica. Pp. 285–305.

Meteorologische Zeitschrift. Wien. Band 18.

Toepler, M. Ueber die Richtung der elektrischen Strömung in Blitzen. Pp. 481–487.

Kostersitz, K. Zur Frage der Errichtung eines astrophysikalisch-meteorologischen Höhenobservatoriums im Semmeringgebiete. Pp. 487–497.

Ernst, J. W. Graphische Wetterbeschreibung. Pp. 497–504.

Draenert, F. M. Das Klima im Thale des Amazonas-Stromes. Pp. 504–515.

Mohn, H. Absolute Maximum-Temperaturen in Norwegen. Pp. 515–518.

Trabert, W. Die Extinktion des Lichtes in einem trüben Medium (Sehweite in Wolken). Pp. 518–524.

Rotch, L. und Hann, J. Ein neues Feld für die Erforschung der höheren Luftschichten mittelst Drachen. Pp. 524–526.

Kassner, C. Hagelthurmwolken. Pp. 526–528.

Mazelle, M. Ausserordentliche Regenintensität. Pp. 528–529.

Hann, J. J. R. Sutton über die Winde von Kimberley. Pp. 529–533.

Toepler, M. Fragen zur Erforschung der Kugelblitze. Pp. 533–534.

Fenyi, J. Ein Resultat der Gewitterregistrirung in Kalocsa. Pp. 534–536.

Fenyi, J. Zur Theorie des Gewitterregistrators. P. 536–537.

Engelen, —. Gewitter-Registrirapparat. Pp. 537–538.

—— Meteorologisches Observatorium auf den Azoren. P. 538.

Riggenbach-Burkhardt, A. Zum Klima von Ober-Mesopotamien. Pp. 538–539.

Woeikof, A. Der Juni 1901 in Südostrussland. Pp. 539–540.

Gerlick, K. Schlauchförmige Wolken. P. 540.

Pocchettino, —. Ergebnisse einiger Messungen der Elektricitätszerstreuung in freier Luft. Pp. 540–542.

—— Ueber die Störungen des normalen atmosphärischen Potentialgefälles durch Bodenerhebungen. Pp. 542–543.

—— Resultate der meteorologischen Beobachtungen in Guatemala im Jahre 1899. Pp. 543.

—— Ausserordentlicher Regenfall auf Lussin piccolo. P. 543.

Pearson's Magazine. London. Vol. 12.

Anderson, Alder. Photographing Cloud-Land. Pp. 10–15.

NOTES BY THE EDITOR.

CLASSIFIED WEATHER TYPES.

On previous pages we have presented three papers on classified weather types. It must not be supposed that this is a new subject, for, aside from the unpublished work of the various forecast officials, Professor Bigelow has published a classification of weather types in United States Weather Bureau Bulletin No. 20, Storms, Storm Tracks, and Weather Forecasting, and a similar classification also appears in his discussion of "The typical local circulation over the United States," in chapter 8 of the Report of the Chief of the Weather Bureau, 1898–99, Vol. II. Russell's Meteorology[1] also con-

[1] Meteorology, Thomas Russell, New York and London, 1895.

tains, on page 188, a description of twenty-two typical weather maps.

The object of the papers here presented, as stated by the writers, is to invite attention to the assistance a forecast official may derive from a file of weather maps, properly classified and indexed. As was to be expected, each of these writers has his own individual classification and his own method of indexing.

Professor Garriott emphasizes the fact that we must first decide what constitutes weather types. What shall guide us in classifying weather maps? Shall we say that because on two maps the distribution of barometric pressure is similar, these maps therefore belong to the same type? We agree with Professor Garriott that this does not necessarily follow. It is the *behavior* of the highs and lows that must be observed in making our classification, rather than their relative position at any given observation. How have they been built up, and what is their direction and rate of motion as compared with the normal for the month? Other meteorological elements, such as temperature and moisture, must also receive due consideration.

Professor Garriott has also pointed out that heretofore we have not received reports from a sufficiently extensive territory to enable us to classify weather types in the manner he indicates. As a rule, it requires but a few days for highs or lows to develop and pass off to the east of the United States, or even to cross the country from the Pacific to the Atlantic. If they fail to pass off within the usual time, we consider the conditions *abnormal*, and the persistency of highs and lows in maintaining a position just off the New England coast for several successive days has been a fruitful source of unverified forecasts.

Arrangements recently perfected by the Chief of the Weather Bureau whereby reports are cabled to the United States from Europe and the islands of the Atlantic enable us to study the movement of storms across the ocean, and it is believed will lead to more accurate forecasts for the United States; for it is evident that the movement of storms across our own country does not depend alone upon the atmospheric conditions here, but is also largely dependent upon the conditions to the east of us, and these have been particularly hard to determine in winter without direct observations because of the marked difference between continental and oceanic conditions during that season. As Professor Bigelow has pointed out,[2] conditions on the continent of North America in winter are particularly favorable to the development of storms.

There are periods when one storm follows another with almost clockwork regularity, only to be followed by a period of seeming stagnation, when apparently the cycle of eastward movements is blocked. It may well be that a knowledge of the conditions entirely around the Northern Hemisphere will be necessary to accurately foresee these periods of activity and of stagnation.

Forecasting based upon a knowledge of weather types without a knowledge of the forces that operate to produce these types, can not be considered strictly scientific. It is not reasoning from cause to effect, but rather an effort is made to correlate present conditions with conditions that existed at some past time and then it is assumed that like results will follow in each case.

With meteorology in its present state of development perhaps this is the best we can hope to do at present. As has been so aptly stated by the Chief of the Weather Bureau[3] the science of meteorology "now awaits the genius of a Kepler or the magic of a Newton to unravel the mysteries that still baffle the student." It awaits a development of the mathematical laws of storms in such form that they can be applied to the every day problems of meteorology.

[2] Report of the Chief of the Weather Bureau, 1898-99, Vol. II, p. 610.
[3] National Geographic Magazine, 1897, Vol. VIII, p. 65.

If we can learn to identify weather types, we have taken the first step toward a study of the forces that generate the types. The Editor therefore recommends to students of meteorology not only the classification and indexing of weather maps according to weather types, but also a critical study of the more important types, and of the apparently abnormal conditions that occasionally exist.

The forecaster must not, however, rely up a familiarity with types for his success in forecasting. No two storms will be found that are exactly similar in all respects. He must, therefore, learn to distinguish the causes that will result in producing certain types of weather or in modifying the current daily map.—*H. H. K*

THE INFLUENCE OF SMALL LAKES ON LOCAL CLIMATE.

In a letter to the Chief of Bureau the following questions have been asked:

1. Do the lakes in central and western New York have an appreciable influence on the amount of rain, snow, fog, or dew, and is this region consequently favored with a greater certainty of crops than neighboring localitities?
2. Is the climate in their neighborhood modified in any particular so as to make it more desirable?

The following extracts are made from the Chief's reply:

There are a number of ways in which lakes affect the climate of their immediate neighborhood:

1. The reflection of the sun's light and heat from the surface of the water has a decided influence in warming the soil on the east, west, and north sides of the lake. If the banks are steep and high this influence is felt to a corresponding elevation above the water, but if they are very low it is inappreciable.

2. Evaporation from the lake surface throws more water into the air than evaporation from the ordinary fields or forests. There is, therefore, an increased tendency to the formation of fogs during the late night hours and calm weather, and a corresponding protection from frosts, up to the limit of the fog.

3. When the wind blows, the vapor being carried to the leeward side increases the chance of forming fog, cloud, and rain to a distance from the lake, depending upon the strength of the wind and the size of the lake. As the surface of the lake is cooler than the surface of the land in the summer time and in the middle of the day, the wind also tends to diminish the range of temperature on the leeward side of the lake.

The actual numerical amount of these lake influences must diminish with the size of the lake. Thus, on the east shore of Lake Michigan there is a region 5 miles broad, and at the southeast a region 10 miles broad, greatly protected by warmth, fog, and cloud when cold west or northwest winds are blowing. Without having any special local observations to guide our estimates we dare only suggest that the small lakes in central New York probably affect local climates very much as Lake Michigan does, but only to an extent proportional to their areas. That is to say, Lake Cayuga, for instance, having an area of 25 square miles, would have an influence of about one one-thousandth part of that of Lake Michigan, with its area of 25,000 square miles. Although local observers might be well persuaded that an occasional cloud or rain or fog is due to the presence of the lake, yet on the average of many years the influence of the lake would be inappreciable, at least so far as items 2 and 3 are concerned.

With regard to the first item, namely, the reflection of heat from the surface of the small lakes, we think that should be appreciable.

In so far as the small lakes occupy depressions into which the cold air may drain in still, clear nights, they do by that process oppose the formation of frost over the neighboring watershed, but this is an influence independent of the lake water, and depending only on the contour of the depression.

A comparatively thick network of observers with thermometers and rain gages would be necessary to convert these general expressions into figures.—*C. A.*

METEOROLOGICAL OBSERVATIONS WITH KITES AT SEA.[1]

On page 419 of the MONTHLY REVIEW for September, 1901, we printed a short note outlining the work that Mr. A. Law-

[1] A. Lawrence Rotch, in Science, N. S., Vol. XIV, No. 362, p. 896, December 6, 1901.

rence Rotch proposed to undertake with kites on a contemplated trip across the Atlantic. We reprint herewith his account of the results of his experiments, which must be considered as in every way successful. Evidently we need to know more of the upper air conditions over the ocean. As has been shown on page 563 of this REVIEW the conditions on the Atlantic must have an important bearing on the movement of storms across our own country. We therefore heartily indorse any movement that will increase our knowledge of oceanic meteorology.

To the Editor of Science: On page 412 of Science I stated that meteorological observations were about to be attempted with kites flown from a transatlantic steamer. With the aid of my assistant, Mr. Sweetland, and through the courtesy of Captain McAuley, this was accomplished on board the Dominion steamship *Commonwealth*, which left Boston for Liverpool on August 28, 1901. During most of the voyage we were within an area of high barometric pressure that was drifting slowly southeastward and out of which light winds blew. Although these were insufficient to raise the kites, the ship's speed of 16 knots created a corresponding wind from an easterly direction that sufficed to lift the kites on five of the eight days occupied by the voyage to Queenstown. On one of the three unfavorable days, a following wind became too light on the ship for kite flying, and on the two other days a fresh head wind, augmented by the forward motion of the ship, was so strong as to endanger the kites, but had it been possible to alter the course of the vessel a favorable resultant wind might have been produced every day. The maximum height attained was only about 2,000 feet, but with larger kites and longer wire this could have been greatly exceeded. Automatic records were obtained of barometric pressure, air temperature, relative humidity, and wind velocity, which did not differ markedly from records obtained in somewhat analogous weather conditions over the land. The most striking feature was the rapid decrease of the temperature with increasing height in all but one of the flights. The *fall* of temperature was fastest in the first 300 feet, where it exceeded the adiabatic rate of 1° Fahrenheit in 183 feet, but in the last-mentioned flight the temperature *rose* 6° in 450 feet, and during the afternoon remained so much warmer than at sea level. The relative humidity varied inversely with the temperature; the direction of the wind shifted aloft toward the right hand, when facing it, and its velocity generally increased with altitude. These are probably the first meteorological observations at a considerable height in the mid-Atlantic, and have a special importance because they indicate that at sea high-level observations may be obtained with kites in all weather conditions, only excepting severe gales, provided the steamer from which the kites are flown can be so maneuvered as to bring the wind to a suitable velocity.

As the basis of an appeal for the exploration of the atmosphere at sea, the records described were exhibited to the geographical section of the British Association at its Glasgow meeting, and the appointment of a committee with a grant of money to undertake observations with kites in Great Britain, together with the interest manifested there and on the continent of Europe, encourages the hope that my project will be realized. The equipping of the English antarctic vessel *Discovery* with meteorological kites, as mentioned on page 779 of Science, and a similar installation on the German antarctic ship *Gauss*, are unlikely, for various reasons, to have yielded much data on their voyages across the Equator. Although the United States has taken no part in this international undertaking, an opportunity is now offered, without material expense, danger, or hardship to cooperate in a study of the general atmospheric circulation, which is one of the objects of polar exploration. Indeed, for a naval vessel not actually engaged otherwise, the sounding of the atmosphere in the Tropics, whereby the relation of the upper air currents to the winds useful for navigation may be ascertained, would seem to be as legitimate a task as sounding the depths of the oceans and determining the currents and temperatures prevailing there. But if our Navy Department will not authorize this, a private expedition should be organized to investigate the questions mentioned in my letter to Science on a new field for kites in meteorology. Since then Professor Hildebrandsson, of Upsala, who is an eminent authority on the circulation of the atmosphere, writes me that a meteorologist on a steamship provided with kites and also with small balloons to ascertain the drift of the upper winds when there are no clouds, by making atmospheric soundings between the area of high barometric pressure in the North Atlantic and the constant southeast trades south of the Equator, and in this way investigating the temperature and the flow of the so-called antitrades, could solve in three months one of the most important problem in meteorology. If any of your readers will furnish the steamer required, I stand ready to carry out these investigations.—*H. H. K.*

CLIMATE AND CROPS.

The United States Department of Agriculture is continually experimenting to ascertain by what means the farmer may increase the quantity and quality of his crops with the least expense to himself. New varieties of seed are introduced; plant diseases are studied, and remedies suggested; different kinds of fertilizers are analyzed, and likewise the soils from different localities; and the needs of the various soils for the crops to which they are adapted are pointed out.

The Division of Chemistry has for a long time been investigating the effect of climate upon crops, especially also as to its effect upon the quality of the crop. As an example of investigation along these lines, we may refer to the recent publication[1] by Dr. Harvey W. Wiley, Chief of the Bureau of Chemistry, On the Influence of Environment upon the Composition of the Sugar Beet.

In his letter of transmittal to the Secretary of Agriculture, Dr. Wiley refers to this work as

> Showing the results of the study of the Division of Chemistry, in collaboration with a number of the experiment stations and with the Weather Bureau, of effect of environment upon the chemical composition of the sugar beet.

The average meteorological conditions at selected stations were considered each month during the season of vegetation, as follows: Mean temperature; total precipitation; hours of sunshine; ratio of actual to possible sunshine, in percentages; number of clear days; number of cloudy days.

In his "Conclusions," Dr. Wiley shows that there is a close relation between latitude and percentage of sugar in the beet; this relation is probably due to the lower temperature in the higher latitudes.

The quality of the beet does not appear to depend upon the amount of direct sunlight it receives, the diffused light coming through the clouds evidently being quite as effective as the direct rays, but the average length of day from sunrise to sunset has a direct relation to the content of sugar in the beet, since the longer the day the higher the percentage of sugar.

The distribution of rainfall by months is also shown to have an important influence upon the sugar content, the best results being obtained with 3 to 4 inches of rainfall per month during May, June, July, and August, and a reduction of the rainfall during September and October.

The close relation between the meteorological conditions and the quality of the sugar beet is clearly set forth in the concluding paragraphs of Dr. Wiley's bulletin, as follows:

> The above conclusions, derived from these studies of a year, are quite in harmony with the theories which already prevail in regard to the effect of seasonal influences upon the sugar content of the beet. There are many problems, however, presented by the data, which offer an inviting field of study. Chief among these is the suggestion, which has already been made in a previous part of this bulletin, that the high temperature line which seems to be so disastrous in its effects upon the sugar content of the beet may not produce all these ill effects directly as the result of the high temperature, but indirectly in the effect produced upon the moisture in the soil, the arrest of growth by dry weather, the inducement of a second growth on the accession of rains following a drought, and in other indirect ways. The study of this problem would best be carried on in an irrigated arid region where the temperature is high during the growing months and where the distribution of water on an experimental plat could be absolutely controlled. Other new problems of interest are also presented in studying the effects of direct and indirect sunshine and the distribution of the hours of direct sunshine compared with indirect and with partly cloudy weather.
>
> In the study of these problems so far we are indebted to the cordial cooperation of the Weather Bureau and experiment stations and in the further elaboration of them we rely on the promise of the continuance of this aid. It is certain that environment, of which meteorological conditions form the chief component, have a most marked influence on the chemical composition of crops, and without the assistance of the Weather Bureau it would be difficult to properly study the extent of the changes produced.

This bulletin indicates the relation between the meteoro-

[1] Bulletin No. 64, United States Department of Agriculture, Bureau of Chemistry, Washington, D. C., 1901.

logical conditions at selected stations and the quality of a single crop. It shows at once that in certain sections sugar beets can not be successfully raised, not because they will not grow, but because the percentage of sugar content is too small. It also shows that apparently high temperature is responsible for the inferior quality of the beet at southern experiment stations.

No doubt similar investigations would disclose equally interesting relations between meteorological conditions and other crops; and in these relations, not alone the farmer, but the whole country is deeply interested.

The investigation of the chemical composition of crops must of course be conducted by the Bureau of Chemistry, but the Weather Bureau, through its corps of more than 3,000 meteorological observers, is able to supply climatic data not otherwise available, and it takes pleasure in cooperating with other bureaus in the promotion of these important investigations.

The Climate and Crop Division of the Weather Bureau is conducting a most important investigation into the relations between the meteorological and the general crop conditions, especially the yield per acre. The crop bulletins, issued weekly during the season of vegetation, summarize for each State the general effect of the weather upon the crops. Any one who is interested in the subject can easily trace, week by week, the effect of abnormal heat, unseasonable cold, excessive rains, or drought upon the various crops. The Bureau of Chemistry is investigating questions that these reports can not touch upon, i. e., the relation between the chemical composition of the crops and these meteorological conditions.

These facts help to emphasize the intimate relations that exist between the work of the various scientific bureaus of the Department of Agriculture. In fact, just such amicable relations should exist between the work of the various scientific bureaus and societies of the whole country. Each can and must draw from and contribute to the work of others; for no science is complete in itself. From mutual cooperation will come mutual advancement.

The importance of the work of our voluntary observers is also clearly shown. The number of fully equipped stations with a paid corps of observers is necessarily limited. Furthermore, most of the first class stations must be located in large cities near the centers of population, where the meteorological conditions differ materially from those that prevail in the agricultural districts. Our voluntary observers are, as a rule, located in the midst of crop producing districts, and they are therefore able to supply just the data required for the study of the relation of the crop to the meteorological conditions. Too much emphasis can not be placed upon the importance of the data they are furnishing, and also upon the necessity for accuracy and faithfulness on the part of the observers who make and record the observations.—*H. H. K.*

THE METEOROLOGICAL SOCIETY OF MAURITIUS.

In a paper read before the Meteorological Society of Mauritius on April 11, 1901, Mr. T. F. Claxton, F. R. A. S., reviewed very briefly the results achieved during the fifty years of its existence. He stated that the society was established on the first day of August, 1851, its primary object being the promotion of meteorological science in general, and especially that branch of it called cyclonology or the laws of storms.

To this end the society undertook the following work:

1. To procure instruments of the best description as standards of comparison, and to endeavor to keep a supply of other instruments at moderate prices for the use of persons in the colony and its dependencies, and of commanders and masters of vessels.
2. To provide for meteorological, magnetical, and tidal observations being made in Mauritius and its dependencies, Rodrigues, Seychelles, Diego Garcia, etc., and to aim at the establishment of a permanent meteorological and magnetical observatory.
3. To tabulate meteorological observations taken daily on board vessels in the Indian Ocean.
4. To collect or procure extracts from any meteorological records existing in the archives of the colony, or in hands of private individuals.
5. To encourage masters of vessels trading to this island to make and record observations on the state of the weather, tides, and currents as experienced in the course of their respective voyages, and to communicate such observations to the society.
6. To correspond and exchange observations with similar societies in other countries.
7. To collate, arrange, and publish the information that may be obtained from the above sources.

Probably the most important work of the society has been in connection with the establishment and maintenance of the Royal Alfred Observatory at Mauritius, the comparison of ships' barometers and chronometers with the standards of this observatory, and the collection and discussion of meteorological data from the log books of vessels and from other sources. Barometer comparisons are effected by means of one or two readings of the ship's barometer that are made by a clerk from the observatory. It would seem that much better comparisons would be obtained if the ship's captain were induced to make daily readings while in port, as is done by our own Hydrographic Office. Not only would a greater number of readings be obtained for comparison, but the personal error of the captain's readings and the chance of introducing new errors would also be eliminated.

The decreased number of vessels now stopping at Mauritius as compared with former years, and also the change from the slow sailing to the faster steam vessels, has seriously diminished the number of observations that can be obtained from ships' log books. To offset this loss special efforts are now being made to establish permanent stations on the various small islands in the Indian Ocean.

It is to be hoped that this may be accomplished, since it will be a source of regret to meteorologists if the valuable studies of cyclones in the Indian Ocean, which have been conducted by the society in years past, should now be curtailed through lack of meteorological data.

Mr. Claxton refers with justifiable pride to the publications of the society. Among these he makes special mention of the daily synoptic weather charts of the Indian Ocean. These commenced with January, 1861, and were published under the direction of Dr. C. Meldrum in 1881. Of late years, owing to the few reports received from vessels, the charts have been published during the hurricane season only.

The Cyclone Tracks published in 1891 is another valuable work, and especially the annual reports of the Royal Alfred Observatory which go far toward filling what would otherwise be a large gap in our meteorological observations in the southern hemisphere. A meteorological atlas of the south Indian Ocean is in preparation.

We heartily congratulate the Meteorological Society of Mauritius upon the results achieved during its half century of work. The members are imbued with the true spirit of investigation, and we look for even better results in the future.

Can not nephoscope observations be made and discussed at the Royal Alfred Observatory?—*H. H. K.*

EARLY METEOROLOGICAL RECORDS.

In the Climate and Crop Report for November, Dr. O. L. Fassig has begun the reprint of some notes by Rev. John Campanius on the weather near Wilmington, Del., during 1644 and 1645. We can but believe that similar ancient records for other parts of the country can be discovered by diligent research. For instance, it was quite the custom for southern planters to keep a daily record of the weather in

connection with the work on the plantation. Although many such manuscripts have long since been destroyed, yet it is quite worth while to continue the search for such as remain, and we shall always be glad to print them in full or in abstract in the MONTHLY WEATHER REVIEW.—*C. A.*

LUNAR HALO AND LUNAR CORONA.

The following is an extract from a letter from Prof. John W. Harshberger, Philadelphia, Pa., dated December 22, 1901:

This evening, about 6 o'clock, I observed such a remarkable lunar halo and cloud formation that I thought a record might be of scientific interest.

The moon was about half way up to the zenith and was surrounded by an inner and an outer halo ring. The moon shone through a compact grayish-white cloud. Suddenly to the south of the moon a deep rift or crack appeared in the cloud, which reminded me of a huge ice crack made from bank to bank of a wide river. The clouds at once began to drift northward and the moon soon shone brightly through the sharply defined rift, which was just wide enough to accommodate the full diameter of the moon. At the same time the halo commenced to fade away and in twenty minutes had disappeared, but the clouds still resembled floe ice, the drift being toward east-northeast.

The small circles around the moon are diffraction circles and differ in origin from the large circles or halos. The former depend on the size and distance apart of the cloud particles, and a slight change in the texture of the cloud may make them disappear, while the large halos of 22° and 45° radius are more enduring. The small circles may originate in fog or haze that is quite near the observer; the larger halos generally belong to the clouds proper and have some local value as indicative of conditions that form approaching rain.—*C. A.*

WEATHER BUREAU MEN AS INSTRUCTORS.

Mr. T. B. Jennings, Section Director, Topeka, Kans., reports that on the 3d he addressed the older scholars of the Jackson School of that city on "The Weather Bureau and its instruments," and the teachers of the same school on "The Weather Bureau and its work." On the 4th he addressed the high school teachers and scholars, combining the above subjects into one lecture.

The Weather Bureau office at Macon, Ga., was visited on the 6th by the physical science class of the Bibb County Normal School, and the work of the office was explained by Mr. John R. Weeks, Observer in Charge, in an informal lecture.

The following is from the Sioux City, Iowa, Journal of December 10, 1901:

Last evening Mr. U. G. Purssell, in charge of the Sioux City office of the United States Weather Bureau, delivered the first number in a lecture course which has been inaugurated under the auspices of the South Sioux City High School and the management of Mr. C. P. Bowman, Superintendent of the Schools of that place.

Mr. Purssell devoted his remarks to the history of the Weather Bureau, its methods of work, and the benefit it has been to the people of the country. After speaking of the growth of the Bureau and the increasing influence of the service, Mr. Purssell entered into a description of weather stations about the country. He spoke of the equipments of these stations and the instruments used. He referred also to the Bureau's telegraphic system, the distribution of warnings and reports to the different interests affected by the weather. He told of the construction and the use of the weather maps, and spoke of the value of meteorological records and climatic data. He also made suggestions for the study of meteorology in the schools.

The lecture was heard by a good audience, which showed much interest.

Mr. J. J. Kelliher, Observer, United States Weather Bureau, Pocatello, Idaho, reports that on the 18th the class in physical geography in the High School of that city visited the Weather Bureau office, and that he exhibited and explained the various meteorological instruments in use.

We quote the following from the Minneapolis, Minn., Journal of November 10, 1901:

Weather maps for schools.—Observer Outram, of the Weather Bureau, receives many calls from the schools in the Northwest and in Minneapolis for sets of weather maps covering several consecutive days. The charts are very helpful in the study of the physics of the atmosphere, since they enable the instructor to point out the movements of the high and low areas, the areas of precipitation, and other interesting meteorological phenomena.

Mr. S. S. Bassler submits the following outline of a course in meteorology which he is to give at the University of Cincinnati, commencing with the second term of the current collegiate year:

A COURSE IN ELEMENTARY AND PRACTICAL METEOROLOGY.

Object of course.—The course is intended to give a knowledge of the leading facts concerning the atmosphere and its phenomena, and to enable the student intelligently to interpret a weather map and make a forecast therefrom.

Outline of the course.—Short talks, in connection with the text-book, on the subjects temperature, pressure, wind, moisture, cyclones and anticyclones, weather and weather maps, proverbs, and forecasting will be given in the order named. Laboratory work in connection with these subjects, singly and in combination, will establish the correlation between them and between general and local weather conditions. The course as outlined in detail largely contemplates self instruction, more especially in the practical part, through observation and reasoning.

Text-book.—Waldo's Elementary Meteorology.

Reference book.—Davis's Meteorology.

Time.—One hour (or more) each alternate Saturday afternoon during the second and third terms, with supplementary hours of study, observation, and practise in the use of instruments and the construction of weather maps.

Work.—Careful study of the text-book as a basis, concise written explanation of problems in the current lesson, essay writing and practise work as prescribed. Base maps and data for map practise will be furnished.

Equipment.—The text-book, the reference book (optional), a note book, blank base maps of the United States, lead pencils, and a red and blue pencil.

Note.—Should the class not be too large, this instruction will be given in the private office of the local forecast official, with whom arrangements may be made.—*H. H. K.*

HALO OF HEVELIUS.

Rev. Frederick Odenbach, S. J., Professor of Physics in St. Ignatius College, Cleveland, Ohio, sends us the following account of his observations of the halo of Hevelius, on December 6, 1901. This was first published in the Cleveland Plain Dealer, December 7, 1901, but numerous corrections have since been made by Father Odenbach.

Preceding a period of low barometric pressure, halos are often noticed about the sun. The commonest of these appear at a distance of 22° from the sun; an outer halo, at a distance of 46°, is also occasionally noted; but the great halo of Hevelius, at a distance of 90°, is a great rarity. At times when these halos are visible, there is also visible a parhelic circle passing through the sun and intersecting the halos. At the points of intersection of the parhelic circle with the halos are formed balls of light, which are known as "mock suns," "dog suns," or "sun dogs." These mock suns are really not reflections of the sun at all, but are merely intensified points of light at the intersections of two light circles. They are scientifically known as parhelia. Tangent to the halos are also occasionally noted tangent circles of equal radius. These are known as contact circles.

Yesterday the inner circle of 22° was complete, portions of the 46-degree circle were distinct, and the great circle of Hevelius was distinct

for half its circumference. Portions of the parhelic circle were visible, and a part of the contract circle to the halo of 46° was the most brilliant and resplendent part of the entire display. Parhelia, or mock suns, were visible on the 22-degree and the 90-degree circles.

The great circle of Hevelius is located at such a great distance from the sun that the whole of its circumference can never be visible. Father Odenbach was working by an eastern window in his observatory when he glanced from his book and noticed a peculiar luminous circular cirrus cloud, as he supposed. He continued his work, but upon glancing up about fifteen minutes later he noted that the supposed cloud had not moved from its former position. He at once saw that it could be no cloud and ran to the roof of his observatory, where the whole series of phenomena was spread out before his eyes.

In the quarter of the heavens opposite to the appearance which he had seen from his window, Father Odenbach saw an exactly similar parhelium or "sun dog." Extending between the two was the great 90-degree circle or halo of Hevellus. Within this were visible portions of the 46-degree circle, with a most brilliant arc of the tangent circle floating in the sky like a rainbow-hued crescent. Within this, resplendent with every color, was the common halo of 22°. Near the points of contact with the halos portions of the parhelic circle were also visible, making brilliant sun dogs at the inner circle, and causing the parhelia on the halo of Hevelius which first attracted the observer's attention. At the point of contact with the 46-degree circle the appearance was not so marked, but traces of the mock suns were noticeable.

It was shortly before 11 o'clock when Father Odenbach first observed the display. It continued undiminished for an hour, but after noon it began to fade. The inner halo, however, was visible all the afternoon.

The inner halo of 22° is caused by crystals of ice in the atmosphere. They have angles of 60°, and the halo is always at the fixed distance of 22° from the sun. This halo contains all the colors of the rainbow, but their order is transposed, the red being on the inner edge, and the violet on the outer.

The halo of 46° is also caused by ice crystals in the air, with the difference that the light passes through the terminal faces inclined at angles of 90°. This halo is not nearly so common as the inner halo, but it has the same rainbow hues.

The great 90-degree circle, or halo of Hevelius, differs essentially from the two inner halos. In the first place it is not rainbow hued, but is merely a band of white light This great halo was first seen by Hevelius, whose name it bears, on February 20, 1661. For some reason the contact arch to the 22-degree circle was not visible yesterday, although that halo itself was very brilliant, while the contact arch to the 46-degree circle was distinct and lustrous in spite of the fact that the 46-degree circle was scarcely discernible. This contact arch was distinctly visible up to 4 o'clock. Throughout the display nothing was visible south of the sun, except a portion of the 22-degree halo. This was due to the hazy and smoky condition of the atmosphere near the horizon.

To summarize this great meteorological display, there were visible yesterday one halo of 22°, one halo of 46°, one halo of 90°, one contact arc of 46°, two mock suns of 22°, and two mock suns of 90°.

The following extracts are from Weather Bureau daily journals for December 6, 1901:

Cleveland, Ohio: Parhelia 22.5° from the sun were observed from 11:45 a. m. to 12:15 p. m., and a tangent halo of 45° radius from 11:45 a. m. to noon. At the station there was considerable smoke present in the air most of the day.

Detroit, Mich.: Faint complete solar halo observed from 10:15 a. m. to 10:40 a. m. Partial solar halo with bright parhelia observed from 1:30 to 2:15 p. m.

Sandusky, Ohio: Very brilliant solar halo with parhelia, and also a brilliant colored arch, red side toward the sun, was observed near the zenith, the convex side being toward the sun and probably 46° from it. This phenomenon prevailed from 12:30 to 2:20 p. m.

Toledo, Ohio: Quite a distinct solar halo of 22° radius was observed during most of the morning from 9 a. m. and ending about noon, with a fainter halo of 45°. A white parhelic circle passing through the sun made a bright parhelion at either intersection with the halo of 22° radius, but there was no visible parhelia at the intersections with the halo of 45°; a faint parhelic circle intersected the halo of 45° and was tangent to the halo of 45° making a very bright contact arch which was plainly visible for a long time.

Richmond, Va.: At about 8 a. m. a solar halo was visible. It consisted of a segment of a circle with prismatic colors about 22° northwest of the sun and having its concave side to the sun. The colors were very distinct. It was accompanied by a sun dog about 10° north of the sun. The display lasted until 10 a. m.

Springfield, Mo.: Faint solar halo 4:10 p. m.

On the morning of the 6th an area of high pressure was central over Ontario, Canada, and an area of low pressure over South Dakota. Most of the stations along the lower lakes and immediately to the west reported the sky partly overcast with cirro-stratus or alto-stratus clouds; farther west the sky was completely overcast with lower clouds, and at some stations rain or snow was falling. At 8 p. m. the lower lake stations reported very few clouds, but on the following morning they were well under the influence of the low barometer area and its attendant cloudiness.

It thus appears that these brilliant solar halos were formed in the layer of upper clouds that usually precedes a barometric depression.—*H. H. K.*

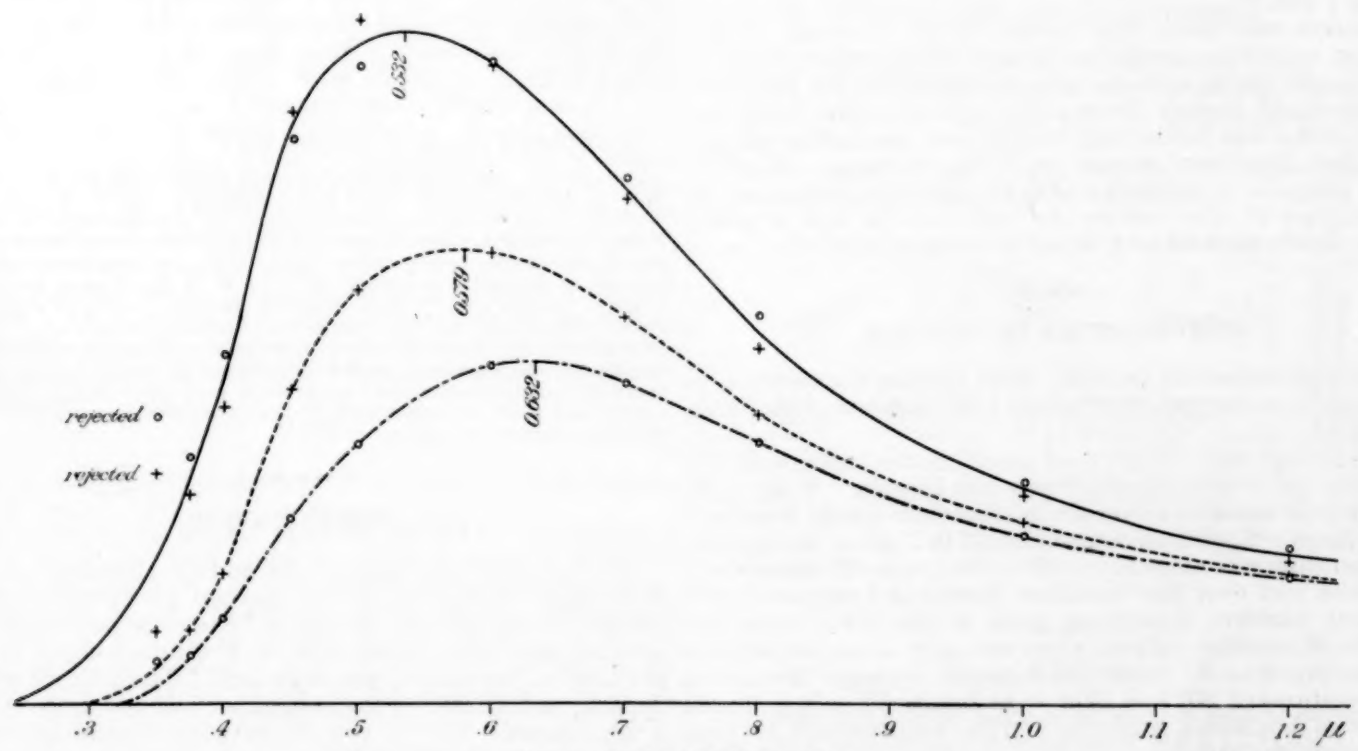


FIG. 1.—Spectral energy curves.

CORRIGENDA.

MONTHLY WEATHER REVIEW for August, 1901, page 362 column 1, line 3 from bottom, for

$$p=\left(\frac{1+\varepsilon_1}{1+\varepsilon_2}\right), \text{ read } p=\left(\frac{1+\varepsilon_1}{1+\varepsilon_2}\right)^m .$$

Page 363, column 1, dele all of line 20 after "curves." and all of line 21, and insert the following in its place:

"In connection with the spectral energy-curves shown in fig. 1, the circles indicate Langley's Lone Pine high-sun observations, August 11, 12, and 14, 1881, and values outside the atmosphere computed from the same. The crosses indicate Mount Whitney observations, September 1, 2, and 3, 1881, and outside values computed by formulæ R and D. Maxima are shown at the following points:" (See fig. 1 on preceding page.)

THE WEATHER OF THE MONTH.

By ALFRED J. HENRY, Professor of Meteorology.

CHARACTERISTICS OF THE WEATHER FOR DECEMBER.

The month of December, 1901, was characterized by heavy rainfall in the eastern and southern sections and by abnormally cold weather in the central and southern districts. A severe cold wave swept across the country from west to east on the 13th, 14th, and 15th. The cold wave was preceded in the Middle Atlantic and New England States by heavy rains and more or less destructive floods. A second period of heavy rain set in toward the end of the month, causing a number of rivers in the Middle and South Atlantic States to pass beyond the flood stage. The weather on the Pacific coast was cloudy and rainy during the first ten days of the month; thereafter, generally fair weather prevailed especially in California and the central and southern Plateau region.

PRESSURE.

The distribution of monthly mean pressure is graphically shown on Chart IV and the numerical values are given in Tables I and VI.

Pressure was below the normal in all portions of the country, except the north Pacific coast, the northern Plateau, and thence southeastward and southward to the Mexican boundary and western Texas. The high over the South Atlantic States was perceptibly weaker than usual although the high over the ocean seemed to be fairly strong. Monthly mean pressure, as compared with the previous month, fell in the interior of the country and rose on the New England coast, also from the Rocky Mountains westward to the Pacific

TEMPERATURE OF THE AIR.

The distribution of monthly mean surface temperature, as deduced from the records of about 1,000 stations, is shown on Chart VI.

The month was colder than usual in the interior of the country, the South Atlantic States, and Florida. West of the Rocky Mountains and over the northeastern Rocky Mountain slope mean temperature ranged from 3° to 7° above the normal. Temperature was also above the normal in northeastern New England and over the Canadian Maritime Provinces. The greatest negative departures were in the lower Ohio and middle Mississippi valleys, where monthly mean temperature was as much as 6° below the seasonal average. Maximum temperatures of 80° and over were registered only in Texas, southern Louisiana, southern Florida, southwestern Arizona, and southern California. In the upper Lake region and northern Minnesota the maximum temperature of the month did not at any time exceed 40°. Minimum temperatures of zero and lower were registered over the greater part of the central and northern districts, and freezing temperatures prevailed to the Gulf coast and over the peninsula of Florida as far south as Tampa.

The average temperature for the several geographic districts and the departures from the normal values are shown in the following table:

Average temperatures and departures from the normal.

Districts.	Number of stations.	Average temperatures for the current month.	Departures for the current month.	Accumulated departures since January 1.	Average departures since January 1.
		°	°	°	°
New England	10	30.8	+ 0.4	— 1.9	— 0.2
Middle Atlantic	12	34.6	— 1.7	— 4.1	— 0.3
South Atlantic	10	45.8	— 2.8	—17.0	— 1.4
Florida Peninsula	7	58.3	— 3.0	—20.3	— 1.7
East Gulf	7	47.4	— 4.9	—15.4	— 1.3
West Gulf	7	47.7	— 3.7	+ 7.7	+ 0.6
Ohio Valley and Tennessee	12	32.7	— 5.4	—10.1	— 0.8
Lower Lake	8	27.4	— 3.1	— 2.0	— 0.2
Upper Lake	9	21.6	— 2.9	+11.1	+ 0.9
North Dakota	8	12.4	— 0.3	+25.5	+ 2.1
Upper Mississippi Valley	11	23.3	— 5.1	+14.9	+ 1.2
Missouri Valley	10	24.6	— 4.7	+29.3	+ 2.4
Northern Slope	7	25.9	+ 1.3	+28.3	+ 2.4
Middle Slope	6	32.8	— 2.0	+20.9	+ 1.7
Southern Slope	6	39.9	— 1.8	+14.0	+ 1.2
Southern Plateau	15	39.8	+ 1.4	+ 9.5	+ 0.8
Middle Plateau	9	30.0	+ 2.2	+19.5	+ 1.6
Northern Plateau	10	32.0	+ 1.5	+20.8	+ 1.7
North Pacific	9	41.5	— 0.3	— 1.1	— 0.1
Middle Pacific	5	49.8	+ 1.2	+ 2.1	+ 0.2
South Pacific	4	54.6	+ 1.8	+ 6.3	+ 0.5

In Canada Prof. R. F. Stupart says:

The extreme western and southwestern counties of the Province of Ontario were the only portions of the Dominion where the mean temperature of the month was below average, the greatest departure, about 5°, being in Essex. Near the shores of Lake Ontario and the Georgian Bay the mean was nearly average, and thence northward and eastward a positive departure increased to 3° or 4° in the Ottawa Valley and western Quebec and to 6° in eastern Quebec. In Nova Scotia and Prince Edward Island the average was exceeded by between 3° and 6°; in Manitoba and Assiniboia by nearly the same amount, while further northward and westward in the Territories, in Saskatchewan and Alberta, the positive departure from average was from 6° to 9°. In British Columbia a positive departure of 3° near the Selkirk range diminished gradually toward the coast.

PRECIPITATION.

On the whole the month was one of abundant rainfall. More than 100 per cent of the normal precipitation was recorded in ten of the twenty-one districts into which the country has been divided, and in five others more than 75 per cent of the normal was registered. The greatest positive departures occurred in the eastern section and extended over a considerable belt of country between Mississippi on the southwest and New England on the northeast. In Texas and

on the Pacific coast, and also on the Plateau region, precipitation was below the seasonal average. There were also small regions of deficient precipitation in northern Florida, southeastern Georgia, the upper Mississippi Valley, and the upper Lake region. The total rainfall for the month over a considerable portion of eastern Alabama, northwestern Georgia, eastern Tennessee, southwestern Mississippi, and eastern Louisiana was above 10 inches.

Average precipitation and departure from the normal.

Districts.	Number of stations.	Average.		Departure.	
		Current month.	Percentage of normal.	Current month.	Accumulated since Jan. 1.
		Inches.		*Inches.*	*Inches.*
New England	10	7.28	198	+3.6	+ 0.3
Middle Atlantic	12	5.84	180	+2.6	− 1.3
South Atlantic	10	4.27	120	+0.7	− 2.0
Florida Peninsula	7	2.93	116	+0.4	+ 1.3
East Gulf	7	6.98	159	+2.6	− 0.5
West Gulf	7	2.47	76	−0.8	−11.3
Ohio Valley and Tennessee	12	5.17	145	+1.6	− 9.5
Lower Lake	8	4.28	149	+1.4	− 1.9
Upper Lake	9	1.63	73	−0.6	− 6.8
North Dakota	8	0.87	130	+0.2	+ 1.3
Upper Mississippi Valley	11	1.70	85	−0.3	−10.2
Missouri Valley	10	1.32	118	+0.2	− 5.1
Northern Slope	7	1.01	198	+0.5	+ 1.5
Middle Slope	6	0.52	57	−0.4	− 6.0
Southern Slope	6	0.56	38	−0.9	− 4.4
Southern Plateau	15	0.22	17	−1.1	− 0.1
Middle Plateau	9	1.17	85	−0.2	− 0.3
Northern Plateau	10	1.76	95	−0.1	− 2.3
North Pacific	9	6.77	76	−2.1	− 0.5
Middle Pacific	5	1.86	33	−3.8	− 2.6
South Pacific	4	0.08	2	−3.2	− 1.1

In Canada Professor Stupart says:

The precipitation was less than average in British Columbia, over the greater part of Manitoba, and also over portions of Quebec and northern Ontario. In all other parts of the Dominion it was greater than average, the most marked excess being in Nova Scotia.

At the close of the month the lower levels in British Columbia, the larger part of Alberta, and the western portions of Assiniboia were bare of snow, as were also Nova Scotia and Prince Edward Island and the southern part of New Brunswick. From Assiniboia eastward over Manitoba, Ontario, Quebec, and northern New Brunswick, the ground was snow-covered, the greatest depth reported being between 16 and 20 inches in Quebec and northern Ontario.

The southern limit of snow extended well to the southward. It did not embrace, however, southern Georgia, southern Alabama, nor southern Texas. No snow fell on the lowlands of Arizona or California. The geographic distribution of snowfall for the month is shown by Chart IX. At the end of the month a light covering of snow was on the ground in eastern Tennessee, eastern Kentucky, northern Ohio, and thence westward to the middle Missouri Valley. The covering of snow in Nebraska and South Dakota was local rather than general, a number of stations reporting an inch or thereabouts, while others reported none. The greatest depth of snow was found in New York, northern New England, northern Michigan, and in the mountain districts of the west. Very little snow appears to be on the ground on the western slope of the Rocky Mountains.

SLEET.

The following are the dates on which sleet fell in the respective States:

Alabama, 14, 19, 29, 30. Arizona, 10, 11, 12. Arkansas, 3, 4, 5, 8, 12, 13, 14. California, 3, 5, 9. Colorado, 4, 10, 11, 12, 19, 24. Connecticut, 3, 4, 23, 26, 27. District of Columbia, 23. Florida, 16, 17. Georgia, 5, 19, 23, 28, 30. Idaho, 5, 8, 26. Illinois, 8, 9, 12, 13, 14, 24, 28, 29. Indiana, 9, 11, 12, 13, 14, 23, 24, 29. Iowa, 1, 4, 5, 6, 7, 8, 10, 12, 13, 23, 26, 28. Kansas, 7, 8, 10, 11, 12, 13, 15, 27, 28. Kentucky, 9, 13, 14, 27. Louisiana, 13, 14, 15, 28, 29. Maine, 8, 9, 15. Maryland, 3, 10, 13, 14, 23, 25, 29. Massachusetts, 3, 4, 24, 25, 27. Michigan, 7, 8, 12, 13, 24, 29. Minnesota, 1, 2, 6, 27, 28. Mississippi, 4, 5, 13, 14, 15, 29. Missouri, 3, 5, 7, 8, 9, 10, 11, 12, 13, 14, 19, 26, 28, 30. Montana, 4, 23. Nebraska, 4, 5, 7, 12, 23, 27. Nevada, 10. New Hampshire, 3, 8, 15. New Jersey, 2, 3, 4, 23, 27. New York, 2, 3, 8, 9, 14, 28, 29. North Carolina, 5, 16, 17, 23, 24. North Dakota, 1, 22, 23, 26. Ohio, 14, 28, 29. Oklahoma, 8, 13. Oregon, 3, 9, 25, 26. Pennsylvania, 3, 9, 14, 15, 23, 25, 26, 27, 28, 29. South Carolina, 5, 19, 22, 23. South Dakota, 2, 3, 4, 22, 23. Tennessee, 10, 14, 15, 22, 30. Texas, 8, 12, 13, 14, 15, 28. Utah, 6, 10, 11. Virginia, 8, 23, 28, 29, 30. Washington, 4, 8, 17, 20, 21, 22, 23, 26. West Virginia, 14, 28, 29. Wisconsin, 8, 12, 13, 28. Wyoming, 2, 8, 24.

HAIL.

The following are the dates on which hail fell in the respective States:

Alabama, 2. Arkansas, 1, 4, 9. California, 11, 12. Kansas, 13. Maine, 15. Missouri, 13. Texas, 8, 13, 28.

HUMIDITY.

The averages by districts appear in the subjoined table:

Average relative humidity and departures from the normal.

Districts.	Average.	Departure from the normal.	Districts.	Average.	Departure from the normal.
	%			%	
New England	79	+ 4	Missouri Valley	79	+ 4
Middle Atlantic	78	+ 4	Northern Slope	77	+10
South Atlantic	78	− 1	Middle Slope	70	+ 5
Florida Peninsula	83	+ 1	Southern Slope	61	− 6
East Gulf	77	− 1	Southern Plateau	37	−11
West Gulf	71	− 2	Middle Plateau	64	− 3
Ohio Valley and Tennessee	81	+ 6	Northern Plateau	80	− 1
Lower Lake	82	+ 4	North Pacific Coast	88	0
Upper Lake	84	+ 3	Middle Pacific Coast	71	−13
North Dakota	81	+ 2	South Pacific Coast	60	−14
Upper Mississippi	82	+ 6			

SUNSHINE AND CLOUDINESS.

The distribution of sunshine is graphically shown on Chart VII, and the numerical values of average daylight cloudiness, both for individual stations and by geographical districts, appear in Table I.

The averages for the various districts, with departures from the normal, are shown in the table below:

Average cloudiness and departures from the normal.

Districts.	Average.	Departure from the normal.	Districts.	Average.	Departure from the normal.
New England	6.4	+0.6	Missouri Valley	5.7	+0.6
Middle Atlantic	5.9	+0.5	Northern Slope	5.6	+1.0
South Atlantic	5.1	+0.4	Middle Slope	4.6	+0.6
Florida Peninsula	4.9	+0.3	Southern Slope	3.6	−0.8
East Gulf	5.8	+0.6	Southern Plateau	2.0	−1.0
West Gulf	4.2	−1.1	Middle Plateau	4.3	−0.8
Ohio Valley and Tennessee	6.7	+0.6	Northern Plateau	6.6	−0.5
Lower Lake	7.5	−0.1	North Pacific Coast	7.6	+0.3
Upper Lake	7.6	+0.5	Middle Pacific Coast	3.3	−2.1
North Dakota	6.3	+1.1	South Pacific Coast	2.7	−1.7
Upper Mississippi	6.5	+0.8			

WIND.

The maximum wind velocity at each Weather Bureau station for a period of five minutes is given in Table I, which

also gives the altitude of Weather Bureau anemometers above ground.

Following are the velocities of 50 miles and over per hour registered during the month:

Maximum wind velocities.

Stations.	Date.	Velocity.	Direction.	Stations.	Date.	Velocity.	Direction.
Block Island, R. I.	3	77	ne.	Mount Tamalpais, Cal	9	50	nw.
Do.	4	58	n.	Do.	24	50	n.
Do.	15	52	nw.	Do.	25	55	n.
Buffalo, N. Y	10	54	sw.	Do.	27	62	n.
Do.	14	54	s.	Nantucket, Mass.	4	54	ne.
Do.	31	51	w.	Neah Bay, Wash.	3	58	e.
Carson City, Nev.	5	50	sw.	Do.	4	52	w.
Cheyenne, Wyo.	23	66	w.	Do.	26	60	w.
Chicago, Ill.	31	54	nw.	New York, N. Y.	4	65	nw.
Denver, Colo.	18	52	n.	Do.	10	60	w.
El Paso, Tex.	12	52	w.	Do.	11	65	nw.
Helena, Mont.	21	55	sw.	Do.	27	50	nw.
Do.	26	56	sw.	Do.	31	66	nw.
Lexington, Ky	13	50	s.	Pensacola, Fla.	28	60	sw.
Modena, Utah	6	54	sw.	Point Reyes Light, Cal.	23	60	nw.
Mount Tamalpais, Cal.	3	60	w.	Portland, Me.	15	58	se.
Do.	5	56	w.	Salt Lake City, Utah	26	50	nw.
Do.	6	55	nw.	Winnemucca, Nev.	5	70	s.

ATMOSPHERIC ELECTRICITY.

Numerical statistics relative to auroras and thunderstorms are given in Table IV, which shows the number of stations from which meteorological reports were received, and the number of such stations reporting thunderstorms (T) and auroras (A) in each State and on each day of the month, respectively.

Thunderstorms.—Reports of 336 thunderstorms were received during the current month as against 261 in 1900 and 353 during the preceding month.

The dates on which the number of reports of thunderstorms for the whole country were most numerous were: 13th, 112; 14th, 35; 12th, 34; 8th, 32.

Reports were most numerous from: Louisiana, 38; Missouri, 36; Arkansas and Texas, 32.

Auroras.—The evenings on which bright moonlight must have interfered with observations of faint auroras are assumed to be the four preceding and following the date of full moon, viz: 21st to 29th.

In Canada: Auroras were reported at Swift Current on the 7th, and 19th. A thunderstorm was reported from New Westminster on the 3d.

DESCRIPTION OF TABLES AND CHARTS.

By ALFRED J. HENRY, Professor of Meteorology.

Table I gives, for about 145 Weather Bureau stations making two observations daily and for about 25 others making only one observation, the data ordinarily needed for climatological studies, viz, the monthly mean pressure, the monthly means and extremes of temperature, the average conditions as to moisture, cloudiness, movement of the wind, and the departures from normals in the case of pressure, temperature, and precipitation, the total depth of snowfall, and the mean wet-bulb temperatures. The altitudes of the instruments above ground are also given.

Table II gives, for about 2,700 stations occupied by voluntary observers, the highest maximum and the lowest minimum temperatures, the mean temperature deduced from the average of all the daily maxima and minima, or other readings, as indicated by the numeral following the name of the station; the total monthly precipitation, and the total depth in inches of any snow that may have fallen. When the spaces in the snow column are left blank it indicates that no snow has fallen, but when it is possible that there may have been snow of which no record has been made, that fact is indicated by leaders, thus (. . . .).

Table III gives, for all stations that make observations at 8 a. m. and 8 p. m., the four component directions and the resultant directions based on these two observations only and without considering the velocity of the wind The total movement for the whole month, as read from the dial of the Robinson anemometer, is given for each station in Table I. By adding the four components for the stations comprised in any geographical division the average resultant direction for that division can be obtained.

Table IV gives the total number of stations in each State from which meteorological reports of any kind have been received, and the number of such stations reporting thunderstorms (T) and auroras (A) on each day of the current month.

Table V gives a record of rains whose intensity at some period of the storm's continuance equaled or exceeded the following rates:

Duration, minutes..	5	10	15	20	25	30	35	40	45	50	60	80	100	120
Rates pr. hr. (ins.)..	3.00	1.80	1.40	1.20	1.08	1.00	0.94	0.90	0.86	0.84	0.75	0.60	0.54	0.50

In the northern part of the United States, especially in the colder months of the year, rains of the intensities shown in the above table seldom occur. In all cases where no storm of sufficient intensity to entitle it to a place in the full table has occurred, the greatest rainfall of any single storm has been given, also the greatest hourly fall during that storm.

Table VI gives, for about 30 stations furnished by the Canadian Meteorological Service, Prof. R. F. Stupart, director, the means of pressure and temperature, total precipitation and depth of snowfall, and the respective departures from normal values, except in the case of snowfall.

Table VII gives the heights of rivers referred to zeros of gages.

NOTES EXPLANATORY OF THE CHARTS.

Chart I, tracks of centers of high areas, and Chart II, tracks of centers of low areas, are constructed in the same way. The roman numerals show number and chronological order of highs (Chart I) and lows (Chart II). The figures within the circles show the days of the month; the letters *a* and *p* indicate, respectively, the 8 a. m. and 8 p. m., seventy-fifth meridian time, observations. Within each circle is also given (Chart I) the highest barometric reading and (Chart II) the lowest pressure at or near the center at that time.

Chart III.—Total precipitation. The scale of shades showing the depth of rainfall is given on the chart itself. For isolated stations the rainfall is given in inches and tenths, when appreciable; otherwise, a "trace" is indicated by a capital T, and no rain at all, by 0.0.

Chart IV.—Sea-level pressure, temperature, and resultant surface winds. The wind directions on this Chart are the computed resultants of observations at 8 a. m. and 8 p. m., daily; the resultant duration is shown by figures attached to each arrow. The temperatures are the means of daily maxima and minima and are reduced to sea level. The pressures are the means of 8 a. m. and 8 p. m. observations, daily, and are reduced to sea level and to standard gravity. The reduction for 30 inches of the mercurial barometer, as formerly shown by the marginal figures for each degree of latitude, has already been applied.

Chart V.—Hydrographs for seven principal rivers of the United States.

Chart VI.—Surface temperatures; maximum, minimum, and mean. Lines of equal monthly mean temperature in red; lines of equal maximum temperature in black; and lines of equal minimum temperature (dotted) also in black.

Chart VII.—Percentage of sunshine. The average cloudiness at each Weather Bureau station is determined by numerous personal observations during the day. The difference between the observed cloudiness and 100, it is assumed, represents the percentage of sunshine, and the values thus obtained have been used in preparing Chart VII.

Chart VIII.—West Indian monthly isobars, isotherms, and resultant winds.

Chart IX.—The total snowfall. This is based on the reports from regular and voluntary observers, and shows the depth of the snowfall during the month in inches. In general, the depth is shown by lines inclosing areas of equal snowfall, but in special cases figures are also given.

Chart X.—Snow on ground on December 31, 1901.

TABLE I.—*Climatological data for Weather Bureau Stations, December*, 1901.

Stations.	Elevation of instruments.			Pressure, in inches.			Temperature of the air, in degrees Fahrenheit.										Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity, per cent.	Precipitation, in inches.			Wind.					Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.
	Barometer above sea level, feet.	Thermometers above ground.	Anemometer above ground.	Mean actual, 8 a. m.+8 p. m.÷2.	Mean reduced.	Departure from normal.	Mean max. + mean min. ÷2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.					Total.	Departure from normal.	Days with .01, or more.	Total movement, miles.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.					
New England.																															
Eastport	76	69	74	29.95	30.04	+ .07	30.8	+ 0.4										79		7.28	+ 3.6								6.4		
Portland, Me.	103	81	117	29.92	30.03	+ .01	29.2	+ 3.7	54	14	36	4	17	23	44	37	24	81		6.02	+ 2.0	16	9,674	n.	48	ne.	4	8	7	16	6.6	22.
Northfield	876	15	65	29.08	30.08	+ .03	28.3	+ 0.9	53	15	35	6	17	22	25	25	20	74		7.14	+ 3.6	14	7,627	nw.	58	se.	15	8	9	14	5.9	21.8
Boston	125	115	181	29.92	30.06	+ .02	21.6	+ 0.2	60	15	30	−17	6	13	54	19	17	84		4.42	+ 1.3	13	7,006	n.	48	s.	14	3	9	19	7.5	21.5
Nantucket	12	43	85	30.04	30.05	.00	32.4	+ 1.3	64	14	40	9	6	25	41	30	26	77		8.49	+ 5.0	13	8,888	nw.	44	se.	15	8	8	15	6.5	12.6
Block Island	26	11	70	30.03	30.06	+ .01	37.2	+ 0.8	55	29	43	16	17	32	26	35	31	82		6.52	+ 2.3	17	12,320	nw.	54	ne.	4	5	6	20	7.5	20.0
Narragansett	.....	10	.....	.....	.....	.....	34.8	− 1.4	58	14	40	9	19	29	29	33	29	79		8.67	+ 5.0	13	14,595	nw.	77	ne.	3	10	7	14	5.9	4.5
New Haven	106	117	140	29.94	30.06	− .02	31.5	− 1.3	56	14	39	6	22	24	30	.....	.....	.....		9.38	+ 5.6	12	.....	sw.	.....	.....	.....	11	5	15	.....	6.0
Mid. Atlan. States.							31.2	− 1.0	59	15	39	5	22	24	42	28	24	77		7.65	+ 4.2	13	7,719	n.	39	s.	15	13	9	9	4.6	6.8
Albany	97	102	115	29.97	30.09	+ .02	34.6	− 1.7										78		6.84	+ 2.6								5.9		
Binghamton	875	79	90	.....	.....	.....	30.8	− 1.8	63	14	35	− 7	7	19	47	24	22	85		5.42	+ 2.7	12	5,987	nw.	36	se.	14	3	12	16	7.0	21.6
New York	314	108	350	29.72	30.07	− .02	26.2	− 2.3	65	14	34	− 6	6	18	33	.....	.....	.....		5.41	+ 2.6	18	5,012	w.	35	sw.	10	4	8	19	7.3	18.8
Harrisburg	374	94	104	.....	.....	.....	34.4	0.0	59	15	41	15	6	28	40	31	27	75		6.05	+ 2.8	14	11,949	nw.	66	nw	31	8	12	11	5.8	1.1
Philadelphia	117	168	184	29.97	30.10	− .02	31.3	− 3.1	64	14	38	9	22	24	36	...	...	...		4.75	+ 1.7	12	5,891	nw.	40	w.	10	7	9	15	6.3	3.4
Scranton	805	111	119	29.19	30.11	.00	35.9	+ 0.4	65	14	43	15	21	29	43	32	28	75		6.72	+ 4.0	13	8,595	nw.	41	s.	15	10	8	13	5.7	1.4
Atlantic City	52	68	76	30.04	30.10	+ .01	28.6	.....	65	14	36	− 5	6	21	33	25	21	77		5.64	.....	14	5,556	nw.	37	s.	14	4	9	18	7.5	15.4
Cape May	17	47	51	30.09	30.11	+ .01	34.8	− 1.6	57	15	42	12	18	28	37	33	30	83		6.00	+ 2.1	10	9,177	n.	41	nw.	15	10	11	10	5.5	5.2
Baltimore	123	68	82	29.96	30.10	− .02	35.3	− 2.6	54	29	42	13	22	29	32	33	.....	.....		4.87	+ 1.0	13	6,894	n.	33	nw.	15	10	11	10	5.2	0.5
Washington	112	59	76	29.99	30.11	− .03	35.2	− 2.3	65	2	42	11	22	28	39	31	28	80		7.07	+ 3.9	12	3,699	nw.	27	w.	10	12	6	13	5.4	0.6
Cape Henry	.....	5	89	.....	.....	.....	34.8	− 1.4	66	14	43	7	22	26	47	30	26	75		7.56	+ 4.6	12	5,693	nw.	38	nw.	15	14	4	13	5.1	0.3
Lynchburg	661	83	88	29.35	30.09	− .05	42.0	− 1.9	71	25	51	20	21	33	40	...	...	...		4.12	+ 0.2	11	11,209	nw.	48	nw.	15	9	8	14	5.9	0.3
Norfolk	91	102	111	30.01	30.12	.00	36.0	− 3.3	69	14	46	8	22	26	42	31	27	77		8.72	+ 5.7	13	3,324	nw.	34	nw.	10	15	7	9	4.8	3.7
Richmond	144	82	90	.....	.....	.....	42.6	− 0.2	71	14	51	16	21	34	47	38	33	75		3.35	− 0.3	12	7,646	s.	36	s.	15	13	8	10	5.1	1.6
S. Atlantic States.							38.6	.....	68	14	48	9	22	30	43	.....	.....	...		6.08	.....	11	4,389	n.	35	sw.	15	11	7	13	5.6	1.0
Charlotte	773	68	76	29.25	30.10	− .04	45.8	− 2.8										78		4.27	+ 0.7								5.1		
Hatteras	11	17	36	30.09	30.10	− .01	40.0	− 3.6	68	14	48	10	21	32	43	36	32	78		5.79	+ 1.7	16	5,398	ne.	40	s.	14	13	2	16	5.8	0.3
Kittyhawk	8	12	30	.....	.....	.....	46.3	− 1.9	68	15	52	22	21	40	28	44	43	88		6.48	+ 1.0	14	12,193	n.	39	n.	6	14	5	12	4.8	T.
Raleigh	376	93	101	29.72	30.14	.00	43.6	− 2.6	66	*	51	18	21	36	28	...	...	...		5.88	+ 1.7	9	11,242	nw.	...	.....	...	16	6	9	4.2	1.0
Wilmington	78	82	90	30.03	30.12	− .01	41.1	− 2.8	72	13	51	10	22	31	47	37	32	75		5.46	+ 2.3	13	4,821	n.	30	nw.	15	15	6	10	4.7	0.6
Charleston	48	14	92	30.06	30.11	− .02	46.8	− 1.5	73	13	56	16	22	37	40	41	38	78		4.72	+ 1.7	14	6,973	n.	41	w.	23	12	8	11	4.8	0.3
Columbia	351	114	122	29.72	30.11	− .03	48.6	− 2.9	72	26	56	21	17	41	35	43	39	77		1.85	− 1.4	13	8,188	n.	34	s.	14	11	9	11	5.2	0.1
Augusta	180	89	103	29.91	30.11	− .02	44.6	− 3.3	73	14	54	16	17	36	38	40	35	78		4.88	+ 1.9	17	6,489	ne.	36	sw.	23	11	6	14	5.9	2.4
Savannah	65	79	89	30.04	30.11	− .04	44.4	− 3.3	73	13	54	13	21	35	35	40	37	80		3.88	+ 0.5	18	4,830	nw.	30	w.	14	7	11	13	5.9	1.1
Jacksonville	43	69	84	30.06	30.11	− .01	49.4	− 3.0	73	25	58	18	21	41	34	43	39	76		1.02	− 2.2	10	5,999	sw.	31	w.	30	12	9	10	4.6	
Florida Peninsula.							52.8	− 3.2	76	26	62	20	21	43	33	47	44	79		2.73	− 0.1	10	5,848	nw.	32	w.	3	11	10	10	4.9	T.
Jupiter	28	13	55	30.05	30.08	− .02	53.7	− 2.5										83		3.53	+ 1.5								4.9		
Key West	22	43	50	30.05	30.07	.00	64.7	− 2.0	80	29	72	38	21	58	26	60	57	83		4.17	+ 1.5	10	8,031	nw.	35	e.	9	9	15	7	5.4	
Tampa	34	60	67	30.06	30.10	+ .02	67.6	− 2.4	79	14	72	50	21	63	14	63	61	81		5.17	+ 3.6	10	8,039	ne.	34	nw.	30	14	10	7	4.8	
East Gulf States.							58.7	− 3.2	80	13	68	24	21	49	32	53	51	86		1.24	− 1.1	7	4,372	nw.	30	w.	30	15	8	8	4.4	
Atlanta	1,174	190	216	28.82	30.11	− .06	47.4	− 4.3										77		6.03	+ 2.6								5.8		
Macon	370	93	99	.....	.....	.....	39.8	− 5.5	68	25	48	6	21	32	42	36	31	75		7.61	+ 3.4	14	10,971	nw.	56	nw.	30	10	8	13	5.7	0.2
Pensacola	56	78	96	.....	.....	.....	43.6	.....	71	13	53	11	21	34	32	...	.....	.....		5.37	.....	12	5,380	nw.	28	sw.	29	10	5	16	5.8	3.0
Mobile	57	88	96	30.04	30.11	− .02	50.4	− 4.1	71	26	59	17	21	42	31	.....	.....	.....		4.05	+ 0.2	12	8,483	n.	60	sw.	28	9	10	12	5.8	
Montgomery	223	100	112	29.86	30.11	− .04	47.6	− 4.8	74	14	57	16	21	38	46	44	41	81		8.44	+ 4.0	8	6,512	n.	34	se.	9	9	6	16	5.9	
Meridian	375	84	98	.....	.....	.....	44.6	− 5.0	72	24	54	12	21	36	46	41	37	78		8.76	+ 4.1	12	5,609	e.	36	sw.	14	9	10	12	5.7	T.
Vicksburg	347	65	76	29.81	30.09	− .06	43.4	− 7.1	72	13	54	13	21	33	52	.....	.....	.....		8.58	+ 3.6	10	5,071	nw.	28	nw.	14	7	10	14	6.3	T.
New Orleans	51	88	121	30.04	30.10	.00	45.2	− 5.4	76	13	54	13	20	36	29	41	36	74		9.97	+ 5.0	11	6,680	se.	31	nw.	14	8	9	14	6.0	T.
Port Eads	.....	27	...	.....	.....	.....	52.0	− 3.5	79	13	61	23	20	44	42	47	43	79		4.86	+ 0.5	7	7,884	se.	36	s.	8	8	12	11	5.5	T.
West Gulf States.							56.0	− 3.5	77	13	65	28	*	47	42	...	...	...		3.61	+ 0.1	12	.....	n.	.....	.....	.....	7	7	17	.....	
Shreveport	249	77	84	29.81	30.09	− .04	47.7	− 3.7										71		2.47	− 0.8								4.2		
Fort Smith	457	79	94	29.58	30.09	− .04	45.2	− 4.3	74	24	55	14	20	35	34	41	37	78		4.16	− 0.5	7	6,550	se.	34	s.	13	13	6	12	5.0	T.
Little Rock	357	93	100	29.70	30.11	− .03	38.8	− 4.0	67	13	49	6	15	29	42	33	27	70		1.88	− 1.2	5	7,872	e.	36	nw.	17	11	10	10	4.7	0.7
Corpus Christi	18	48	53	30.06	30.08	− .02	39.8	− 5.2	71	24	49	6	15	31	34	35	30	71		4.21	− 0.1	8	6,558	nw.	40	nw.	13	13	5	13	5.3	T.
Fort Worth	670	106	114	29.36	30.09	− .04	56.4	− 2.9	86	13	67	20	15	46	46	51	47	77		0.45	− 0.9	3	7,661	n.	36	n.	28	18	11	2	2.8	
Galveston	54	106	112	30.01	30.06	− .04	46.5	.....	82	24	58	9	15	34	44	38	31	63		0.59	.....	4	9,949	nw.	38	s.	18	15	10	6	3.8	0.3
Palestine	510	73	79	29.54	30.11	− .02	53.2	− 3.9	72	1	60	25	15	47	27	51	48	85		3.98	0.0	10	9,923	nw.	42	nw.	28	9	12	10	5.2	
San Antonio	701	67	77	29.34	30.10	− .01	47.1	− 4.3	77	24	57	13	15	37	38	40	35	69		2.43	− 1.4	5	6,341	s.	32	nw.	17	14	10	7	4.1	0.2
Taylor	583	55	63	.....	.....	.....	53.5	− 1.4	84	12	67	15	15	40	40	44	35	57		0.15	− 1.8	3	6,347	se.	35	nw.	28	17	6	8	3.4	
Ohio Val. & Tenn.							49.4	.....	79	12	63	13	15	36	41	.....	.....	.....		0.44	.....	2	8,315	nw.	40	nw.	8	18	4	9	3.8	
Chattanooga	762	106	112	29.29	30.14	− .02	32.7	− 5.4										81		5.17	+ 1.6								6.7		
Knoxville	1,004	10	88	29.01	30.13	− .05	37.6	− 6.0	67	25	46	5	15	29	51	34	29	76		8.07	+ 3.8	16	5,627	n.	38	sw.	9	8	7	16	6.2	3.7
Memphis	397	140	154	29.68	30.13	− .02	35.0	− 4.9	70	14	41	0	21	26	50	32	30	87		12.34	+ 8.2	16	5,425	ne.	42	sw.	9	7	10	14	6.6	5.7
Nashville	546	128	134	29.52	30.13	− .02	37.8	− 5.8	70	24	46	2	15	30	32	34	29	75		4.43	+ 0.3	10	8,276	nw.	40	nw.	13	9	10	12	5.7	5.4
Lexington	989	75	102	.....	.....	.....	34.6	− 7.1	67	13	43	− 2	20	26	37	32	29	81		4.51	+ 0.8	14	5,866	nw.	36	s.	13	6	9	16	6.4	4.6
Louisville	525	114	136	29.51	30.11	− .04	31.2	− 6.9	68	13	39	− 8	15	24	63	...	...	...		3.50	+ 0.1	16	8,369	s.	50	s.	13	4	13	14	6.8	3.4
Evansville	434	72	82	.....	.....	.....	32.4	− 6.0	67	13	40	− 7	15	25	40	30	27	83		4.59	+ 0.7	12	6,452	s.	34	se.	13	7	11	13	6.3	5.1
Indianapolis	822	154	164	29.17	30.10	− .02	30.4	.....	65	13	37	− 6	15	24	38	.....	.....	.....		4.65	.....	9	5,815	nw.	33	s.	13	12	5	14	5.6	7.4
Cincinnati	628	152	157	29.40	30.11	− .03	26.9	− 6.2	62	1	33	−10	15	21	34	24	19	74		4.09	+ 0.9	7	7,883	se.	38	s.	13	7	9	15	6.5	7.0
Columbus	824	87	100	29.17	30.10	− .02	31.0	− 5.6	67	13	38	− 7	15	24	47	28	24	79		3.37	+ 0.2	11	6,072	se.	36	n.	9	7	7	17	7.0	6.7
Pittsburg	842	116	123	29.14	30.08	− .04	28.7	− 4.6	65	14	36	− 7	21	21	51	26	23	84		3.61	+ 0.7	11	5,941	sw.	30	nw	14	4	10	17	7.2	3.5
Parkersburg	638	77	84	29.41	30.13	− .02	33.0	− 2.0	71	13	40	4	16	26	36	29	25	77		4.84	+ 2.0	16	4,778	nw.	29	nw.	10	4	10	17	7.2	10.2
Elkins	1,940	41	50	27.96	30.11	− .04	32.0	− 4.6	72	13	40	− 5	16	24	43	29	27	86		3.57	+ 0.3	14	4,287	nw.	30	w.	9	3	10	18	7.3	2.7
Lower Lake Region.							29.6	.....	66	14	40	− 6	22	19	49	26	24	89		6.92	.....	17	3,187	n.	32	w.	9	0	15	16	7.6	5.5
Buffalo	767	178	206	29.18	30.05	.00	27.4	− 3.1										82		4.23	+ 1.4								7.5		
Oswego	335	76	87	29.66	30.05	.00	29.1	− 0.7	64	14	35	6	16	23	40	27	23	79		5.52	+ 2.2	21	11,428	w.	54	sw.	10	0	11	20	8.5	27.3
Rochester	523	81	90	29.46	30.05	.00	27.6	− 1.8	66	14	34	3	22	21	32	25	22	83		6.08	+ 2.7	17	9,389	s.	45	nw.	31	1	4	26	8.6	30.1
Erie	713	92	102	29.25	30.05	− .01	27.8	− 0.8	62	14	34	5	21	21	36	26	23	81		4.17	+ 1.3	13	6,656	sw.	40	nw.	31	3	8	20	7.8	14.5
Cleveland	762	190	201	29.21	30.07	− .01	29.4	− 3.0	65	13	35	0	21	23	39	27	25	86		3.84	+ 0.6	16	8,973	sw.	41	s.	14	1	6	24	8.1	10.6
Sandusky	629	62	70	29.36	30.08	− .01	28.2	− 3.0	65	13	34	− 6	21	22	43	25	21	75		4.21	+ 1.6	14	11,610	sw.	48	se.	13	5	7	19	7.3	14.4
Toledo	628	123	127	29.36	30.08	.00	26.6	− 5.9	65	13	33	− 7	21	20	29	25	21	81		3.25	+ 0.8	7	5,884	sw.	30	nw.	31	6	8	17	7.0	7.6
Detroit	730	160	190	29.23	30.06	− .01	25.5	− 5.2	62	1	32	− 8	21	19	27	24	20	83		3.53	+ 1.1	9	7,105	sw.	34	se.	13	10	8	13	6.1	6.6
Upper Lake Region.							25.4	− 4.1	58	1	31	− 6	21	20	27	24	22	86		3.66	+ 1.1	8	8,248	sw.	37	s.	13	8	6	17	6.9	12.9
Alpena	609	63	80	29.33	30.03	.00	21.6	− 2.9										84		1.63	− 0.6								7.6		
Escanaba	612	43	57	29.32	30.02	− .01	23.4	− 1.4	44	13	29	1	18	18	21	21	19	86		1.64	− 0.8	9	7,180	w.	42	nw.	31	1	7	23	8.8	9.0
Grand Haven	632	55	92	29.31	30.03	− .01	20.8	− 0.6	41	1	28	−13	16	14	30	19	18	92		0.69	− 1.2	9	6,257	w.	35	nw.	31	4	9	18	7.5	5.7
Houghton	668	66	74	.....	.....	.....	25.4	− 4.2	50	13	31	− 5	21	20	25	24	22	86		3.07	+ 0.4	16	8,368	se.	37	w.	31	1	7	25	8.6	20.6
Marquette	734	79	116	29.16	30.00	− .03	19.7	.....	40	25	26	−11	16	13	32	...	...	...		1.93	.....	19	4,344	nw.	32	nw.	31	3	4	24	8.2	19.9
Port Huron	638	70	120	29.35	30.08	+ .02	21.0	− 1.8	41	1	26	− 9	15	16	22	19	16	80		2.04	− 0.4	16	8,761	nw.	39	nw.	31	2	7	22	8.1	24.9
Sault Ste. Marie	614	40	61	29.29	29.99	− .01	24.9	− 2.9	55	13	31	− 5	21	19	24	23	21	86		2.85	+ 0.5	11	8,370	sw.	40	nw.	31	4	13	14	7.0	6.2
Chicago	823	241	274	29.15	30.08	+ .01	19.8	− 2.8	39	1	26	− 4	15	14	26	18	16	86		0.92	− 1.2	13	5,799	se.	54	nw.	31	5	3	23	8.0	10.2
Milwaukee	681	124	142	29.29	30.07	.00	24.0	− 5.3	57	1	29	−12	15	19	41	23	19	85		1.70	− 0.6	11	11,657	w.	48	s.	13	8	8	15	6.7	4.2
Green Bay	617	49	57	29.35	30.06	.00	22.4	− 3.2	54	1	28	−14	15	17	39	21	18	83		1.69	− 0.3	8	7,571	w.	25	se.	12	6	8	20	7.2	7.4
Duluth	702	95	115	29.24	30.06	− .02	19.6	− 4.2	38	1	26	−20	15	13	29	18	14	78		1.06	− 1.4	13	5,369	sw.	28	n.	3	6	6	19	7.3	8.2
North Dakota.							14.8	− 3.0	43	30	21	−26	14	8	36	12	8	79		0.68	− 0.7	10	7,160	nw	39	nw.	19	11	3	17	6.0	7.1
Moorhead	935	54	60	29.01	30.11	− .04	13.9	+ 0.7										81		1.05	+ 0.5								6.3		
Bismarck	1,674	16	29	28.23	30.14	− .01	11.2	− 0.7	36	22	19	−32	14	3	31	11	9	91		1.36	+ 0.6	10	7,216	nw.	32	se.	4	9	4	18	6.4	13.6
Williston	1,875	15	31	27.99	30.10	− .07	14.7	0.0	41	29	22	−26	14	7	34	12	6	68		0.96	+ 0.3	11	6,624	nw.	34	w.	21	7	4	20	6.9	9.6
	1,875	15	31	27.99	30.10	− .07	15.7	+ 2.7	45	29	25	−28	14	7	43	16	13	84		0.83	+ 0.1	11	6,970	nw.	42	w.	21	11	10	10	5.5	8.3

TABLE I.—*Climatological data for Weather Bureau Stations, December, 1901*—Continued.

Stations.	Elevation of instruments: Barometer above sea level, feet.	Elevation of instruments: Thermometers above ground.	Elevation of instruments: Anemometer above ground.	Pressure, in inches: Mean actual, 8 a. m. + 8 p. m. ÷ 2.	Pressure, in inches: Mean reduced.	Pressure, in inches: Departure from normal.	Temperature of the air, in degrees Fahrenheit: Mean max. + mean min. ÷ 2.	Temperature: Departure from normal.	Temperature: Maximum.	Temperature: Date.	Temperature: Mean maximum.	Temperature: Minimum.	Temperature: Date.	Temperature: Mean minimum.	Temperature: Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew-point.	Mean relative humidity, per cent.	Precipitation, in inches: Total.	Precipitation: Departure from normal.	Precipitation: Days with .01, or more.	Wind: Total movement, miles.	Wind: Prevailing direction.	Wind: Maximum velocity: Miles per hour.	Wind: Maximum velocity: Direction.	Wind: Maximum velocity: Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.
Upper Mis. Valley.							23.3	— 5.1										82	1.70	— 0.3									6.5	
Minneapolis	.....	99	208	.....	.....	.....	15.9	— 4.2	44	30	23	—27	14	8	37	...	...	....	0.46	— 1.0	9	8,446	nw.	38	nw.	29	6	10	15	....	7.2
St. Paul	837	114	124	29.12	30.09	— .02	15.8	— 3.0	40	30	23	—25	14	8	39	14	12	83	0.54	— 0.7	11	5,869	nw.	30	n.	29	8	8	15	6.2	4.9
La Crosse	714	70	78	.....	.....	.....	18.0	— 5.6	40	22	24	—23	14	12	38	...	...	....	0.46	— 1.0	10	4,928	s.	25	n.	29	7	10	14	6.2	4.8
Davenport	606	71	79	29.39	30.09	— .03	22.8	— 5.0	49	1	29	—13	14	17	42	21	19	87	1.33	— 0.4	7	5,258	w.	24	nw.	13	9	5	17	6.5	2.1
Des Moines	861	84	88	29.15	30.15	+ .01	21.9	— 4.9	47	6	29	—18	15	15	36	20	18	84	1.03	— 0.4	9	5,575	nw.	25	nw.	18	7	13	11	6.1	7.9
Dubuque	698	101	109	29.30	30.10	.00	21.8	— 4.1	45	1	27	—17	14	16	39	19	16	82	1.44	— 0.4	10	5,452	nw.	28	nw.	14	3	9	19	7.4	3.0
Keokuk	614	63	78	29.40	30.10	— .02	25.2	— 4.6	56	13	32	—12	20	18	50	22	19	82	1.17	— 0.8	9	5,445	nw.	26	nw.	13	8	6	17	6.2	3.1
Cairo	356	87	93	29.72	30.13	.00	32.6	— 6.6	66	24	40	— 4	20	25	39	29	26	82	4.02	+ 0.7	11	7,265	s.	38	n.	13	7	8	16	6.4	7.1
Springfield, Ill.	644	82	93	29.38	30.11	— .02	25.5	— 7.3	61	1	31	—11	20	20	23	23	20	82	2.70	0.0	9	7,090	s.	29	s.	13	7	5	19	7.0	5.5
Hannibal	534	75	110	.....	.....	.....	26.6	— 5.3	61	1	34	—18	20	19	55	...	...	....	1.82	+ 0.3	11	6,243	sw.	32	s.	12	7	9	15	6.6	4.6
St. Louis	567	111	210	29.46	30.11	— .02	30.2	— 5.4	62	12	37	—10	20	24	43	27	23	78	3.72	+ 0.9	7	7,688	s.	27	n.	29	6	9	16	6.6	6.9
Missouri Valley.							24.6	— 4.7										79	1.32	+ 0.2									5.7	
Columbia	784	4	84	.....	.....	.....	26.9	— 7.9	62	12	36	—23	20	18	38	....	....	....	2.29	+ 0.3	9	6,402	nw.	32	nw.	29	9	7	15	6.2	9.1
Kansas City	963	78	95	29.05	30.14	— .02	28.4	— 3.5	52	24	35	— 8	14	22	31	25	21	77	1.67	+ 0.1	8	6,462	nw.	32	nw.	28	11	5	15	5.7	4.3
Springfield, Mo	1,324	100	103	28.62	30.10	— .02	31.3	— 7.3	60	12	40	—11	20	23	43	28	25	82	3.98	+ 1.1	5	8,634	se	36	s.	12	13	9	9	4.9	9.7
Topeka	.....	81	....	.....	.....	.....	28.7	— 6.1	56	23	36	— 8	14	21	30	....	....	....	0.94	0.0	9	.....	nw.	31	nw.	28	7	13	11	6.0	4.7
Lincoln	1,189	75	84	28.77	30.12	— .03	25.2	— 5.2	57	6	34	—13	14	17	32	22	18	79	0.52	— 0.2	6	8,295	n.	42	nw.	16	12	9	10	4.9	5.7
Omaha	1,105	115	121	28.87	30.12	— .05	23.6	— 3.1	53	6	31	—16	14	16	31	21	18	84	0.73	— 0.3	9	6,776	n.	31	nw.	16	10	11	10	5.8	7.2
Valentine	2,598	39	40	27.24	30.11	— .05	21.7	— 5.5	56	6	32	—34	14	11	43	19	15	79	0.93	+ 0.6	8	6,963	nw.	42	nw.	16	9	13	9	5.3	14.7
Sioux City	1,135	96	164	.....	.....	.....	20.3	— 3.8	47	30	27	—22	14	13	34	...	...	....	0.63	— 0.5	8	8,761	nw.	44	nw.	6	8	11	12	5.7	8.4
Pierre	1,572	43	50	28.37	30.14	— .03	22.2	— 2.5	50	30	30	—19	19	15	35	19	14	73	0.86	+ 0.4	11	5,354	n.	41	nw.	6	6	7	18	6.6	6.5
Huron	1,306	56	67	28.64	30.14	— .04	17.4	— 1.8	46	6	26	—22	14	9	37	15	12	81	0.60	0.0	9	7,749	nw.	39	se.	4	8	12	11	6.1	4.6
Yankton†	1,233	52	58	.....	.....	.....	.....	.....	....	....	....	....	....	....	....	....	....	....	.....	.....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Northern Slope.							25.9	+ 1.3										77	1.01	+ 0.5									5.6	
Havre	2,505	46	47	27.32	30.07	— .08	28.2	+ 7.6	54	29	36	—13	13	20	38	25	21	79	0.62	0.0	7	9,694	sw.	48	sw.	29	8	12	11	5.5	3.9
Miles City	2,371	42	50	27.48	30.10	— .06	24.2	+ 4.9	52	29	33	—24	14	15	32	22	20	91	0.65	+ 0.3	6	4,692	s.	38	w.	16	18	8	5	3.9	3.5
Helena	4,110	88	93	25.83	30.18	+ .01	26.9	+ 1.6	48	1	34	— 3	12	20	33	24	19	69	1.71	+ 0.8	9	5,396	sw.	56	sw.	26	3	9	19	7.3	17.0
Kalispell	2,965	45	51	27.00	30.21	+ .06	28.0	.....	44	23	33	4	12	23	25	26	23	82	1.06	.....	10	3,463	w.	36	sw.	26	4	7	20	7.9	5.5
Rapid City	3,234	46	50	26.58	30.07	— .10	26.8	— 3.4	58	29	38	—24	14	16	50	23	18	74	0.38	+ 0.1	8	6,052	nw.	38	n.	18	14	7	10	4.8	3.7
Cheyenne	6,088	56	64	23.92	30.20	+ .05	26.2	— 2.3	57	30	36	—22	14	17	36	22	16	66	1.62	+ 1.3	12	10,277	nw.	66	w.	23	8	15	8	5.2	15.7
Lander	5,372	26	36	24.63	30.25	+ .08	21.7	+ 0.9	57	23	34	—24	14	9	44	18	14	81	1.87	+ 1.4	8	2,739	sw.	36	sw.	26	6	20	5	5.2	16.5
North Platte	2,821	43	52	27.09	30.18	+ .01	27.2	+ 6.1	67	23	39	—30	14	16	44	22	18	75	0.19	— 0.4	2	6,730	w.	38	nw.	18	9	14	8	5.5	3.0
Middle Slope.							32.3	— 2.0										70	0.52	— 0.4									4.6	
Denver	5,291	79	151	24.68	30.18	+ .02	33.8	+ 1.8	74	23	47	—14	14	21	39	26	18	62	0.89	+ 0.2	10	7,103	sw.	52	n.	18	14	9	8	4.5	10.3
Pueblo	4,685	80	86	25.26	30.14	.00	32.0	— 1.7	73	23	47	—13	14	17	50	25	16	60	0.39	— 0.1	7	5,022	nw.	46	w	18	13	10	8	4.8	4.0
Concordia	1,398	42	47	28.58	30.15	.00	29.6	— 3.4	63	23	39	—10	14	20	44	25	22	81	T.	— 0.5	0	5,725	n.	24	nw.	16	15	5	11	4.7	0.1
Dodge	2,509	44	52	27.41	30.14	.00	32.7	+ 0.1	71	6	46	— 4	14	19	46	26	21	73	0.08	— 0.6	6	7,942	nw.	44	nw.	18	15	10	6	4.5	0.4
Wichita	1,358	78	85	28.62	30.12	+ .01	32.6	— 5.3	64	28	42	— 6	14	23	33	27	22	72	0.52	— 0.4	7	7,442	n.	34	nw.	16	16	6	9	4.5	0.9
Oklahoma	1,214	54	62	28.76	30.11	.00	36.3	— 3.8	70	31	46	— 2	14	26	34	31	25	69	1.26	— 1.2	3	8,115	n.	36	n.	28	13	12	6	4.4	5.0
Southern Slope.							41.1	— 0.8										61	0.20	— 0.9									3.6	
Abilene	1,738	45	54	23.24	30.12	— .02	45.2	— 2.3	80	24	57	9	14	33	39	36	28	61	0.36	— 1.1	2	7,399	nw.	31	nw.	1	16	9	6	3.9	1.0
Amarillo	3,676	54	61	26.24	30.12	— .01	37.0	+ 0.7	74	6	48	— 1	14	26	41	29	20	61	0.04	— 0.7	2	11,747	nw.	48	n.	7	21	5	5	3.2	0.2
Southern Plateau.							44.5	+ 1.9										37	0.06	— 0.9									2.0	
El Paso	3,762	10	110	26.22	30.12	+ .01	46.8	+ 0.7	77	6	61	19	15	32	45	34	19	40	0.03	— 0.5	1	7,679	nw.	52	w.	12	21	8	2	2.2	T.
Santa Fe	7,013	47	50	23.22	30.14	+ .02	32.8	+ 2.0	57	6	44	5	28	22	30	25	16	54	0.20	— 0.6	4	5,304	nw.	34	nw.	18	26	4	1	2.0	1.2
Flagstaff	6,907	12	25	23.36	30.25	.....	32.8	+ 2.3	65	18	49	0	13	17	50	27	...	....	0.14	.....	3	.....	e.	....	.....	...	19	9	3	2.7	1.5
Phoenix	1,108	47	57	28.88	30.08	— .01	52.2	— 0.4	80	5	68	24	14	36	41	38	30	32	0.00	— 1.1	0	2,625	e.	22	n.	27	21	8	2	2.5	
Yuma	141	16	50	29.90	30.05	+ .02	56.8	+ 0.9	83	5	71	24	14	43	36	42	21	27	0.00	— 0.5	0	5,272	n.	42	n.	27	30	1	0	0.6	
Independence	3,910	51	58	26.10	30.13	+ .03	45.4	+ 6.1	67	5	58	21	13	33	34	34	15	31	0.06	— 1.9	2	6,241	nw.	44	w.	6	19	12	0	2.2	
Middle Plateau.							33.0	+ 1.8										64	0.78	— 0.6									4.3	
Carson City	4,720	82	92	25.41	30.29	+ .16	36.6	+ 2.4	64	22	50	9	13	23	43	30	24	64	0.86	— 1.3	4	4,452	sw.	50	sw.	5	20	3	8	3.3	T.
Winnemucca	4,344	59	70	25.76	30.26	+ .07	32.6	+ 1.5	61	5	44	6	13	21	38	28	23	68	0.87	— 0.4	6	6,827	sw.	70	s.	5	15	4	12	4.9	0.6
Modena	5,479	10	38	24.69	30.33	.....	30.5	.....	63	23	-45	— 3	13	16	39	23	14	57	0.12	.....	2	6,250	w.	54	sw.	6	19	6	6	3.3	2.1
Salt Lake City	4,366	105	110	25.74	30.29	+ .07	32.8	0.0	59	5	39	11	13	26	26	28	24	71	1.16	— 0.5	14	3,577	se.	50	nw.	26	9	9	13	5.6	6.9
Grand Junction	4,608	43	51	25.46	30.29	+ .10	30.0	+ 3.2	66	6	42	0	13	18	37	24	16	62	0.21	— 0.2	4	2,961	nw.	32	sw.	7	13	9	9	4.3	3.0
Northern Plateau.							33.1	+ 1.7										80	1.61	— 0.4									6.6	
Baker City	3,471	53	58	26.58	30.30	+ .13	29.4	+ 0.9	47	4	36	12	17	23	22	27	23	79	1.66	— 0.1	12	3,923	nw.	33	sw.	26	7	7	17	6.6	7.8
Boise	2,739	61	68	27.34	30.29	+ .06	35.6	+ 2.4	55	5	43	18	12	28	26	32	28	76	1.76	— 0.2	9	2,607	nw.	24	nw	26	13	11	7	5.0	0.2
Lewiston	757	52	61	.....	.....	.....	38.1	.....	64	23	44	23	16	32	26	....	....	....	2.14	.....	13	2,462	e.	34	w.	26	6	8	17	6.7	T.
Pocatello	4,482	46	54	25.58	30.26	+ .04	29.8	+ 3.8	57	23	37	1	12	23	31	27	23	74	1.62	+ 0.1	9	7,671	se.	38	w.	26	7	8	16	6.5	4.6
Spokane	1,943	99	107	28.11	30.24	+ .12	33.1	+ 1.8	49	1	38	15	12	28	19	31	29	83	0.91	— 1.6	12	3,985	sw.	38	sw.	26	3	3	25	8.3	T.
Walla Walla	1,000	65	73	29.13	30.24	+ .13	37.5	— 0.2	59	23	43	23	20	32	28	36	35	90	2.11	— 0.1	14	3,972	s.	40	sw.	26	5	11	15	6.6	3.5
N. Pac. Coast Reg.							41.5	— 0.3										88	6.77	— 2.1									7.6	
Neah Bay	50	7	50	30.09	30.15	+ .21	43.7	+ 0.7	55	7	47	32	12	40	17	42	40	88	14.92	— 1.4	22	8,499	se.	60	w.	26	4	4	23	7.8	
Port Crescent	259	14	20	.....	.....	.....	39.8	+ 0.4	52	25	44	25	12	35	17	....	....	....	6.35	— 0.6	19	2,534	sw.	40	sw.	4	2	6	23	8.2	
Seattle	123	114	121	30.08	30.21	+ .18	42.4	+ 0.6	54	1	46	28	12	38	18	40	38	84	2.45	— 3.7	15	4,751	se.	33	se.	4	3	9	19	7.5	
Tacoma	213	113	120	.....	.....	.....	40.8	— 0.1	54	1	46	24	12	36	20	....	....	....	4.63	— 2.8	18	5,036	sw.	36	sw.	26	1	2	28	8.6	T.
Astoria	20	57	64	.....	.....	.....	42.7	— 1.3	56	31	48	30	12	38	19	....	....	....	9.91	— 1.3	17	.....	ne.	....	.....	...	8	4	19	6.9	
Portland, Oreg	154	203	213	30.08	30.25	+ .17	41.1	— 0.2	56	1	45	26	12	37	14	40	39	90	4.01	— 3.8	20	6,112	se.	44	s.	22	2	4	25	8.7	T.
Roseburg	518	56	67	29.69	30.27	+ .16	39.7	— 2.3	60	3	44	24	13	35	20	38	37	92	5.10	— 1.4	16	1,918	e.	30	sw.	3	7	16	8	5.3	
Mid. Pac. C'st Reg.							49.8	+ 1.2										71	1.86	— 3.8									5.3	
Eureka	62	60	69	30.18	30.24	+ .17	47.6	— 0.2	64	1	54	32	12	41	20	45	42	83	4.43	— 3.8	10	3,438	se.	36	n.	23	13	9	9	4.7	
Mount Tamalpais	2,375	11	18	27.68	30.17	.....	49.8	.....	65	20	55	31	12	45	16	41	29	50	2.60	.....	5	15,722	nw.	62	n.	27	20	6	5	2.8	
Red Bluff	332	50	56	29.84	30.20	+ .08	49.2	+ 2.5	68	19	58	29	14	40	37	43	38	70	1.56	— 3.8	6	4,006	n.	31	n.	27	20	5	6	3.0	
Sacramento	69	106	117	30.11	30.19	+ .08	47.2	+ 0.1	66	24	56	28	15	39	30	44	39	76	1.19	— 3.0	4	5,553	se.	40	nw.	24	19	5	7	3.3	
San Francisco	155	161	167	30.03	30.19	+ .09	52.9	+ 1.5	72	24	59	41	15	47	22	48	44	75	0.90	— 4.1	5	4,895	n.	29	sw.	3	21	4	6	2.9	
Point Reyes Light	.....	12	16	.....	.....	.....	52.1	+ 2.2	67	22	58	38	12	46	22	....	....	....	1.21	— 4.2	5	8,722	nw.	60	nw.	23	20	6	5	3.0	
S. Pac. Coast Reg.							54.6	+ 1.8										60	0.08	— 3.2									3.7	
Fresno	330	67	70	29.82	30.17	+ .05	47.4	+ 1.1	66	5	58	27	18	36	32	53	38	75	0.16	— 1.3	2	2,635	nw.	22	nw.	5	15	8	8	3.8	
Los Angeles	338	74	82	29.70	30.06	+ .01	58.4	+ 3.0	86	18	72	31	13	45	40	46	35	50	0.00	— 4.0	0	3,061	ne.	18	nw.	7	19	11	1	2.4	
San Diego	87	94	102	29.95	30.05	.00	57.8	+ 2.0	76	27	67	35	13	48	31	48	38	58	0.02	— 2.1	2	3,571	ne.	27	e.	27	27	3	1	2.2	
San Luis Obispo	201	10	46	29.92	30.14	+ .08	54.6	+ 1.2	79	18	69	25	13	40	48	45	36	59	0.12	— 4.4	1	3,540	n.	25	n.	24	22	7	2	2.3	
West Indies.																															
Basseterre	29	41	54	29.93	29.96	.....	78.0	.....	84	2	83	70	15	73	12	72	70	76	2.79	.....	23	7,213	e.	25	e.	10	12	18	1	4.5	
Bridgetown	30	57	65	29.89	29.92	.....	78.9	.....	86	22	84	68	21	74	15	74	72	78	3.82	+ 0.7	20	6,237	e.	24	e.	28	10	8	13	5.5	
Cienfuegos	52	62	67	29.97	30.02	.....	71.6	.....	85	25	79	53	22	64	30	65	63	83	1.79	.....	7	6,318	ne.	24	sw.	29	16	10	5	4.3	
Grand Turk	11	6	20	.....	.....	.....	76.4	.....	87	3	83	67	*	70	20	....	....	....	3.73	.....	19	.....	e.	....	.....	...	4	15	12	6.2	
Havana	57	87	105	29.98	30.04	.....	70.1	.....	85	14	76	56	21	64	19	66	65	89	1.13	— 1.0	7	9,146	e.	40	e.	8	10	13	8	5.4	
Kingston	286	38	52	29.65	29.95	.....	76.9	.....	88	4	85	67	28	69	19	70	68	81	1.42	.....	7	4,051	ne.	27	nw.	31	12	17	2	4.5	
Port of Spain	40	65	66	29.86	29.90	.....	78.5	.....	88	11	85	69	21	72	17	73	71	81	4.93	.....	23	2,698	e.	15	e.	10	5	9	17	7.1	
Puerto Principe	352	55	62	29.67	30.02	.....	72.2	.....	87	16	80	52	31	64	26	67	66	90	0.52	.....	7	6,129	ne.	27	e.	8	9	7	15	6.2	
Roseau	25	37	47	29.91	29.93	.....	78.8	.....	89	23	85	70	19	73	18	71	68	70	3.23	.....	17	4,016	ne.	24	ne.	13	9	16	6	5.0	
San Juan	82	48	90	29.90	29.98	.....	77.0	.....	86	24	82	68	14	72	15	72	70	82	8.43	+ 4.1	21	8,361	e.	36	e.	9	11	15	5	4.5	
Santiago de Cuba	82	46	52	29.90	29.98	.....	75.4	.....	87	3	83	64	14	68	21	69	67	83	2.54	.....	7	5,552	n.	31	nw.	21	12	12	7	5.1	
Santo Domingo	57	87	44	29.93	29.99	.....	76.5	.....	87	25	84	66	28	69	18	71	70	86	2.71	.....	15	4,424	n.	17	n.	9	10	18	3	4.6	
Willemstad	75	39	46	29.80	29.87	.....	79.4	.....	87	1	84	71	21	75	11	74	73	81	3.80	.....	19	6,963	e.	23	e.	11	1	25	5	6.0	

NOTE.—The data at stations having no departures are not used in computing the district averages. * More than one date.

TABLE II.—*Climatological record of voluntary and other cooperating observers, December*, 1901.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Alabama.	°	°	°	*Ins.*	*Ins.*
Ashville	68	4	38.6	10.87	T.
Benton	.....	.....	.....	6.35	T.
Bermuda	71[f]	12[h]	42.7[d]	9.65	
Birmingham	72	5	43.0	9.07	
Bridgeport	.....	.....	.....	7.95	0.5
Calera	.....	.....	.....	6.92	
Camp Hill	72	9	43.7	9.99	0.5
Citronelle	78	13	49.4	7.39	
Clanton	67[e]	10[e]	40.2[e]	4.15	0.5
Cordova	.....	.....	.....	5.37	T.
Daphne	76[e]	12[e]	47.9[e]	6.42	
Decatur	70	1	40.2	6.41	T.
Demopolis	.....	.....	.....	7.54	
Elba[f]	74	12	44.9	.....	
Eufaula[a]	72	12	45.2	5.13	
Eutaw	73	9	41.0	9.96	T.
Evergreen	77	14	48 8	6.19	
Flomaton	77	13	48.2	6.78	
Florence[a]	.....	.....	.....	4.57	1.0
Florence[b]	70	0	38.5	4.43	2.0
Fort Deposit	73	11	43.2	10.92	
Gadsden	70	8	38.8	10.07	
Goodwater	71	9	40.8	7.76	0.2
Greensboro	71	10	41.9	7.63	0.1
Greenville	.....	.....	.....	12.55	
Hamilton	69	1	39.0	5.57	2.5
Highland Home	74	11	43.6	.....	
Letohatchee	.....	.....	.....	9.00	
Livingston[a]	73	9	41.0	5.78	
Lock No. 4	70	8	40.0	8.38	T.
Madison	68	1	37.8	8.44	1.2
Maplegrove	70	5	37.1	11.94	T.
Marion	73	10	43.9	4.60	T.
Newbern	72	8	43.8	7.10	0.5
Newburg	67	1	38.2	5.75	2.5
Notasulga	.....	.....	.....	7.67	
Oneonto	69	1	39.3	10 23	1.0
Opelika	68	9	41.5	10.88	T.
Oxanna	73	8	42.7	8.40	2.0
Prattville	74	11	44.5	.....	.....
Pushmataha	74	9	44.8	7.94	T.
Riverton	71	0	36.2	5.86	2.0
Scottsboro	68	4	35.6	6.60	1.8
Selma	75	11	43.4	6.57	T.
Talladega	71	7	41.4	7.44	0.5
Tallassee	.....	.....	.....	12.77	T.
Thomasville	75	11	47.2	2.69	
Tuscaloosa	70	8	39.8	8.46	
Tuskegee	76	11	45.2	11.46	
Union Springs	73	10	43.8	8.45	T.
Uniontown	74[e]	10[e]	42.2[e]	8.86	T.
Valleyhead	67	5	38.6	9.45	T.
Verbena	.....	.....	.....	7.24	
Wetumpka	75	12	43.1	8.96	
Alaska.					
Juneau	46	13	34.4	13.33	10.0
Sitka	51	19	37.2	10.18	5.0
Arizona.					
Allaire Ranch	.....	.....	.....	0.17	
Arizona Canal Co. Dam	76	22	51.6	0.00	
Aztec	.....	.....	.....	0.00	
Benson[s1]	70	21	47.1	0.00	
Bisbee	73	18	46.8	0.10	0.5
Bowie[s2]	78	24	52.5	0.00	
Buckeye	76	18	48.6	0.00	
Casagrande[s1]	79	31	49.9	0.00	
Champie Camp	83	18	52.2	0.00	
Cochise[s1]	70	19	46.4	0 07	0.2
Congress	73	28	54.6	0.00	
Dragoon[s1]	68	16	46.5	T.	T.
Dudleyville	78	15	47.6	0.07	
Duncan	74	11	41.5	0.10	
Fort Apache	74	6	37.4	1.80	
Fort Defiance	60	— 9	27.9	0.43	4.0
Fort Grant	88	17	50.0	T.	T.
Fort Huachuca	74	27	52.1	0.01	0.1
Fort Mohave	81[e]	29[e]	49.8[e]	0.00	
Gilabend[s1]	75	26	51.9	0.00	
Globe	76	18	47.7	T.	
Ingleside	80	20	50.2	0.00	
Jerome	70	20	46.0	0.00	
Kingman	74	22	50.0	0.00	
Maricopa[s1]	75	30	47.3	0.00	
Mesa	79	17	49.8	T.	
Mohawk Summit[s1]	81	33	57.7	0.00	
Mount Huachuca	72	15	48.0	0.29	T.
Natural Bridge	.....	.....	.....	0.00	
Nogales	77	13	47.4	0.08	0.8
Oracle	70	19	48.4	T.	
Oro	.....	.....	.....	0.00	
Parker	92	19	54.0	0.00	
Phoenix	80	20	50.2	0.00	
Pima	74	14	44 0	0.12	
Pinal Ranch	.....	.....	.....	0.16	1.0
Prescott	68	4	36.6	0.00	
St. Johns	72	— 1	32.4	0.80	8.0
Sentinel[s1]	82	32	56.6	0.00	
Showlow	.....	.....	.....	0.30	3.0
Signal	82	12	48.8	0.00	
Silverking	.....	.....	.....	0.00	
Strawberry	64	4	37.4	0.05	0.5
Superstition	.....	.....	.....	T.	
Taylor	.....	.....	.....	0.25	2.5
Tombstone	72	17	47.6	0.14	T.
Tonto	70	18	44.7	0.01	
Tuba	64[d]	12[d]	33.9[d]	0.00	
Tucson	83	10	50.4	0.00	
Vail[s3]	78	27	51.8	0.20	2.0
Walnutgrove	.....	.....	.....	0.00	
Willcox[s1]	72	16	40.7	0.10	1.0
Yarnell	.....	.....	.....	0.00	
Arkansas.					
Amity	69	9	38.4	6.26	T.
Arkadelphia	73	10	43.6	4.24	
Arkansas City	.....	.....	.....	4.51	T.
Batesville	73	0	38.8	5.30	
Beebranch	87	2	41.2	5.95	T.
Blanchard	74	10	43.9	4.20	T.
Brinkley	70	4	39.2	4.10	3.0
Camden[a]	.....	.....	.....	5.73	2.5
Camden[b]	72	10	41.1	5.40	2.0
Conway	72	5	39.6	4.93	T.
Corning	69	— 3	33.5	4.98	8.7
Dallas	73	5	40.2	5.43	2.0
Dardanelle	.....	.....	.....	5.73	1.0
Fayetteville	68	— 3	35.2	3.48	0.2
Fulton	.....	.....	.....	5.05	
Hardy	67	— 4	44.6	.....	.....
Helena[a]	.....	.....	.....	4.04	.....
Jonesboro	76	14[d]	41.2	6.03	1.0
Keesees Ferry	69	— 4	36.4	3.62	2.5
Lutherville	73	2	38.2	4.58	1.0
Malvern	74	7	42.3	5.70	T.
Marianna	70	3	37.7	3.98	3.5
Marvell	70	4	39.6	4.33	2.0
Mossville	66	— 6	34.2	4.00	1.3
Mount Nebo	66	— 2	36.2	4.98	2.0
New Gascony	73	7	39.2	4.65	1.8
Newport[a]	.....	.....	.....	5.53	0.5
Newport[b]	72	1	37.2	5.18	T.
Newport[c]	69	2	37.0	5.33	2.8
Oregon	69	— 5	35.0	3.71	0.2
Osceola	70	0	37.6	3.85	1.1
Ozark	64	3	38.2	3.30	0.5
Pinebluff	71	5	38.8	4.34	2.0
Pocahontas	68	— 4	35.2	4.19	0.4
Pond	70	— 4	35.4	2.63	3.0
Prescott	72	11	41.1	4.01	0.2
Rison	76	4	40.3	1.92	0.5
Rosadale	76	9	43.4	5.04	1.0
Russellville	70	7	37.0	4.41	0.8
Silversprings	71	— 2	36.4	0.99	1.0
Stuttgart	70	4	39.2	3.92	2.3
Texarkana	73	12	40.6	4.34	T.
Warren	72	7	43.6	5.79	3.0
Washington	70	9	42.2	5.00	0.1
Wiggs	73	5	40.0	6.07	T.
Winchester	73	8	39.6	4.67	T.
Winslow	65	— 4	34.4	2.11	2.0
Witts Springs	68	1	34.8	5.97	3.0
California.					
Angiola	74	14	45.4	T.	
Azusa	.....	.....	.....	0.01	
Bakersfield	75	19	46.0	0.10	T.
Ballast Point L. H.	.....	.....	.....	0.08	
Bear Valley	.....	.....	.....	5.92	4.0
Berkeley	69	37	50.5	1.48	
Bishop	81	16	44.6	0.12	
Boca	63	8	25.8	3.77	
Bodie	53	— 5	24.6	0.40	4.0
Bowman	64	18	42.4	8.01	5.5
Branscomb	.....	.....	.....	9.61	
Caliente[s1]	80	28	50.0	0.00	
Campbell	70	27	48.0	0.30	
Cape Mendocino L. H.	.....	.....	.....	3.25	
Cedarville	57	8	33.0	1.75	4.5
Chico[s1]	73	33	50.6	0.73	
Claremont	83	24	54.6	0.02	
Corning[s1]	72	30	50.6	1.05	
Crescent City	60	29	46.8	9.50	
Crescent City L. H.	.....	.....	.....	9.32	
Cuyamaca	63	6	39.3	0.52	3.0
Delano[s1]	69	24	47.0	0.00	
Delta[s1]	69	28	48.8	5.55	
Drytown	64	24	46.0	.....	
Dunnigan[s1]	67	28	47.4	0.46	
Durham[s5]	62	28	47.1	1.62	
East Brother L. H.	.....	.....	.....	0.70	
Edmanton[s1]	62	17	38.2	6.81	8.0
Elcajon	86	24	55.8	0.43	
Elmdale	70	23	45.6	0.65	
Elsinore	90	22	56.0	0.00	
Escondido	83	16	52.2	0.05	
Fallbrook	82	24	55.9	T.	
Folsom[s1]	66	29	46.8	1.70	
Fordyce Dam	.....	.....	.....	6.12	4.5
Fort Ross	68	35	51.7	5.09	
Foster	.....	.....	.....	0.12	
Georgetown	71	26	48.5	5.51	
Gilroy (near)	76	22	48.8	0.30	
Glendora	.....	.....	.....	0.00	
Grass Valley	.....	.....	.....	4.98	
Greenville	60	12	36.6	3.66	1.0
Hanford	70	30	43.5	0.15	
Healdsburg	73	23	48.8	2 04	
Hollister	70	19	47.5	0.21	
Humboldt L. H.	.....	.....	.....	4.35	
Idylwild	.....	.....	.....	0.34	6.2
Indio[s1]	78	23	53.4	0.00	
Iowa Hill[s1]	68	32	49.2	6.08	
Jackson	64	23	44.6	3.22	
Kennedy Gold Mine	61	21	42.5	3.75	
King City[s1]	68	22	47.6	0.00	
Kono Tayee	62	31	47.2	1.19	
Laguna Valley	.....	.....	.....	0.35	5.0
Lamesa	.....	.....	.....	0.00	
Laporte[s1]	60	17	38.6	8.16	6.1
Legrand	.....	28	.....	0.47	
Lemoncove	86	24	49.6	0.05	
Lick Observatory	67	22	46.6	1.61	T.
Lime Point L. H.	.....	.....	.....	1.30	
Lodi	63	26	45.6	1.48	
Los Gatos[b]	65	30	48.6	0.73	
Mammoth[s1]	80	31	57.1	0.00	
Manzana	72	16	47.2	T.	
Mare Island L. H.	.....	.....	.....	0.86	
Merced[b]	64	24	44.8	0.43	
Mills College	.....	.....	.....	1.57	
Milo	.....	.....	.....	0.27	
Milton (near)	63	27	47.4	1.76	
Modesto[s1]	79	32	50.8	0.64	
Mohave[s1]	65	30	45.7	0.00	
Mokelumne Hill[s3]	.....	33	45.0	2.86	
Monterio	78	22	51.6	0.75	
Monterey[s5]	67	28	51.0	0.53	
Mount St. Helena	.....	.....	.....	5.00	
Mutah	.....	.....	.....	0.00	
Napa	73	29	50.0	2.15	
Nevada City	65	21	43.7	5.35	
Niles	67	30	48.8	1.19	
North Bloomfield	79	23	47.0	5 87	
North Ontario	78	28	54 1	0.06	
North San Juan[s1]	69	26	40.8	7.10	
Oakland	71	34	50.0	0.90	
Oleta[s1]	63	26	43.0	4.06	
Orland[s1]	72	30	50.1	0.87	
Palermo	65	26	46.6	1.93	
Paso Robles	68	16	44.1	0.00	
Peachland[s5]	72[d]	26	49.0	2.98	
Piedras Blancas L. H.	.....	.....	.....	0.20	
Pigeon Point L. H.	.....	.....	.....	0.31	
Pilot Creek	.....	.....	.....	6.35	2.0
Pine Crest	82	39	61.2	0.00	
Placerville	62	30	42.2	3.58	
Point Ano Nuevo L. H.	.....	.....	.....	0.94	
Point Arena L. H.	.....	.....	.....	2.38	
Point Bonita L. H.	.....	.....	.....	2.36	
Point Conception L. H.	.....	.....	.....	0.00	
Point Fermin L. H.	.....	.....	.....	1.00	
Point George L. H.	.....	.....	.....	3.33	
Point Hueneme L. H.	.....	.....	.....	0.00	
Point Lobos	63	40	51.8	1.12	
Point Loma L. H.	.....	.....	.....	0.00	
Point Montara L. H.	.....	.....	.....	1.28	
Point Pinos L. H.	.....	.....	.....	0.68	
Point Sur L. H.	.....	.....	.....	1.59	
Pomona (near)	83	24	54.6	0.00	
Poway	.....	.....	.....	0.22	
Quincy	56	15	34.8	4.23	
Redding	72	27	48.6	4.37	
Redlands	84	29	56.3	T.	
Reedley	69	26	47.0	0.15	
Represa	64	28	46.8	1.88	
Riovista	68	25	46.4	1.20	
Riverside	88	26	54.6	T.	
Roe Island L. H.	.....	.....	.....	0.94	
Rohnerville	.....	.....	.....	4.93	
Rosewood	72	24	46.2	2.00	
Sacramento	64	28	46.0	1.24	
Salinas[s1]	74	25	55.4	0.20	
Salton[s1]	80	32	57.6	0.00	
San Bernardino	88	22	55.4	0.04	
San Jacinto	82	21	53.2	T.	
San Jose	72	29	50.4	0.43	
San Leandro	66	30	48.1	1.40	
San Luis L. H.	.....	.....	.....	0.00	
San Mateo[s5]	62	34	49.2	1.16	
San Miguel[s1]	68	19	45.6	0.00	

TABLE II.—*Climatological record of voluntary and other cooperating observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
California—Cont'd.	°	°	°	*Ins.*	*Ins.*
San Miguel Island	69	47	58.4	1.70	
Santa Barbara	81	37	57.4	T.	
Santa Barbara L. H.	.....	.....	.....	0.03	
Santa Clara	....	.....	.....	0.36	
Santa Cruz	75	25	49.4	1.80	
Santa Cruz L. H.	.....	.....	.....	2.02	
Santa Maria	80	23	54.3	0.01	
Santa Paula	85	33	61.2	0.00	
Santa Rosa [1]	72	25	53.0	2.25	
Shasta	75	29	50.9	4.76	
Sierra Madre	78	35	58.6	0.02	
Sonoma	.....	.....	.....	2.28	
Stockton	63	25	45.0	1.35	
Storey	68	24	44.3	0.25	
Summerdale	69	13	44.6	2.85	1.0
Susanville	56	18	35.4	1.89	T.
Tehama [1]	67	34	52.4	1.00	
Tejon Ranch	75	30	50.8	0.60	
Trinidad L. H.	.....	.....	.....	5.28	
Tulare *b*	.....	.....	.....	0.02	
Tulare *c*	78	18	48.4	0.03	
Ukiah	68	21	45.2	2.76	
Upperlake	70	21	46.8	2.09	
Upper Matole [1]	68	25	43.2	6.30	
Vacaville [1]	72	30	49.0	1.48	
Ventura	88	36	59.5	0.00	
Visalia *b*	75	20	44.6	0.02	
Volcano Springs [1]	86	26	54.4	0.00	
Wasco	74	21	45.7	0.13	
Westpoint	.....	.....	.....	3.77	T.
West Saticoy	.....	.....	.....	0.00	
Wheatland	68	26	46.0	1.53	
Williams [5]	66	35	50.5	0.27	
Wilmington [1]	76	29	50.0	0.00	
Wire Bridge [5]	65	25	45.8	3.75	
Yerba Buena L. H	.....	.....	....	0.95	
Yreka	58	18	36.0	3.09	T.
Zenia	.....	.....	.....	6.82	
Colorado.					
Alford	60	—29	27.1	1.17	19.0
Arkins	.....	.....	.....	1.68	15.0
Ashcroft	.....	.....	.....	0.90	17.6
Blaine	78	—18	33.7	0.07	1.4
Boulder	65	—11	35.0	1.43	15.0
Boxelder	.....	.....	.....	2.47	27.0
Breckenridge	49	—21	15.8	2.86	46.4
Buenavista	.....	.....	.....	0.40	6.0
Canyon	69	—21	35.6	0.74	7.0
Castlerock	68	—17	30.5	0.59	8.4
Cedaredge	60	4	30.3	0.17	2.0
Cheyenne Wells	72	—21	29.5	0.33	4.5
Collbran	58	— 9	26.4	0.65	10.5
Colorado Springs	69	—13	32.2	0.18	5.2
Delta	66	2	29.8	0.18	1.5
Durango	59	— 1	29.7	0.10	1.0
Fort Collins	65	—31	28.5	1.37	15.5
Fort Morgan	73	—21	30.6	0.27	3.5
Fox	.....	.....	.....	0.40	5.5
Gilman	.....	.....	.....	3.06	40.8
Gleneyrie	64	—11	33.2	0.42	6.0
Greeley	59	—28	26.2	1.06	12.0
Grover	.....	.....	.....	0.53	6.0
Gunnison	58	—15	22.0	0.42	4.8
Hamps	69	—21	27.4	0.64	7.5
Hoehne	78	—18	34.0	0.66	5.7
Holly	71	—10	31.8	0.01	0.3
Holyoke (near)	78	—30	27.6	1.27	8.5
Hugo	.....	.....	.....	0.89	11.0
Husted	75	—22	29.4	0.35	2.5
Lake Moraine	46	—19	22.6	0.48	12.0
Lamar	79	—13	32.5	0.19	1.5
Laporte	.....	.....	.....	1.51	19.7
Las Animas	77	—19	29.4	0.38	5.5
Lay	52	— 23	20.8	1.23	17.5
Leadville (near)	.....	.....	.....	1.90	31.0
Leroy	60	—20	27.4	0.89	9.1
Longs Peak	51	—14	23.4	1.00	17.0
Meeker	57	—20	23.4	1.92	18.4
Mitchell	.....	.....	.....	0.78	14.0
Montrose	....	.....	.....	0.25	2.2
Moraine	55	—23	20.7	1.15	16.1
Pagoda	52	—20	23.2	1.59	15.7
Parachute	61	—11	25.8	0.57	6.2
Perrypark	.....	.....	.....	T.	T.
Rangely	53	—11	24.0	0.44	4.5
Rockyford	75	—16	30.4	0.32	3.5
Rogers Mesa	62	3	29.8	0.28	2.4
Ruby	.....	.....	.....	2.60	41.0
Russell	52	—28	21.0	0.61	9.5
Saguache	63	— 5	27.7	0.12	2.0
Salida	64	—24	31.4	1.27	14.0
San Luis	57	—17	25.7	0.25	2.6
Santa Clara	62	—16	29.6	0.88	13.5
Sapinero	.....	.....	.....	0.51	7.5
Seibert	.....	.....	.....	0.50	6.5
Silt	59	— 4	27.0	1.09	9.2
Colorado—Cont'd.					
Sugarloaf	48	—14	25.3	1.40	20.0
Trinidad	81	— 9	36.6	0.55	10.0
T. S. Ranch	...	.....	.....	0.55	6.5
Twinlakes	...	.....	.....	0.40	8.0
Vilas	.....	.....	.....	T.	T.
Wagon Wheel	57	—31	21.8	0.42	6.2
Walden	42	—24	18.8	0.61	8.5
Wallet	.....	.....	.....	0.44	5.0
Westcliffe	54	—16	26.9	0.80	12.5
Whitepine	.....	.....	.....	2.02	20.6
Wray	69	—23	29.8	0.91	10.0
Yuma	.....	.....	.....	0.57	7.0
Connecticut.					
Bridgeport	56	3	31.5	9.55	2.3
Canton	57	— 7	27.1	9.07	11.0
Colchester	63	— 2	31.7	10.05	5.0
Falls Village	.....	.....	.....	8.16	15.0
Hartford *b*	58	2	29.0	9.72	10.0
Hawleyville	69	4	30.4	12.60	0.5
Lake Konomoc	.....	.....	.....	10.46	.....
Middletown	61	— 3	29.4	11.18	8.2
New London	58	7	31.2	6.98	4.0
North Grosvenor Dale	64	— 5	28.2	10.43	.....
Norwalk	60	0	29.4	8.58	1.3
Southington	59	— 5	28.8	9.80	6.8
South Manchester	.....	.....	.....	7.24	10.0
Storrs	68	0	29.7	9.55	5.5
Voluntown	67	— 9	30.2	10.74	3.0
Wallingford	.....	.....	.....	8.16	3.0
Waterbury	59	0	30.0	9.82	11.0
West Cornwall	56	— 2	26.6	8.14	15.8
West Simsbury	.....	.....	.....	8.06	11.0
Delaware.					
Milford	69	8	37.0	5.81	T.
Millsboro	66	7	34.9	5.73	T.
Newark	66	6	31.5	7.26	T.
Seaford	68	9	36.2	5.22	T.
District of Columbia.					
Distributing Reservoir [5]	64	12	34.1	6.79	.....
Receiving Reservoir [5]	64	5	32.8	7.55	.....
West Washington	66	6	33.5	8.44	0.3
Florida.					
Archer	82	20	54.0	2.54	T.
Bartow	87	27	63.0	2.01	
Bonifay	76	16	50.7	3.00	
Brooksville	81	22	55.6	2.50	
Carrabelle	71	17	50.6	2.11	
Clermont	85	26	60.8	0.73	
De Funiak Springs	76	12	49.8	4.18	
Deland	83	22	56.7	.....	
Eustis	83	23	59.4	1.94	
Federal Point	79	22	54.8	2.65	
Fernandino	77	20	52.6	3.37	
Flamingo	85	39	65.8	2.60	
Fort Meade	88	24	58.7	2.95	
Fort Pierce	83	30	61.0	3.91	
Gainesville	80	19	54.8	2.97	
Holt	75	17	48.4	2.13	
Huntington	81	20	55.8	2.28	
Hypoluxo	83	40	66.2	3.94	
Inverness	80	22	54.0	3.99	
Jasper	77	18	50.5	1.90	
Kissimmee	81	24	59.4	1.35	
Lake Butler	80	19	54.3	3.71	
Lake City	80	18	54.2	3.21	
Macclenny	82	18	54.0	3.72	
Manatee	84	27	59.8	2.21	
Marco	82	36	64.6	1.82	
Marianna	82	15	50.8	2.93	
Merritt Island	80	30	58.1	2.36	
Miami	87	39	67.6	1.55	
Micanopy	81	20	55.2	1.35	
Middleburg	83	18	52.3	3.45	
Myers	82	32	59.7	1.62	
New Smyrna	83	25	57.2	0.91	
Nocatee	89	26	61.0	3.64	
Ocala	82	20	56.1	2.91	
Orange City	84	23	57.9	1.59	
Orlando	81	25	58.5	1.28	
Plant City	84	23	57.3	1.81	
Quincy	78	15	49.5	3.56	
St. Andrews	76	18	51.8	3.72	
St. Augustine	79	22	51.5	2 27	
Sumner	83	18	53.3	2.45	
Switzerland	80	21	55.7	3.12	
Tallahassee	74	17	50.0	1.96	
Tarpon Springs	86	23	58.4	1.29	T.
Titusville	82	25	58.0	1.90	
Waukeenah	77	16	49.6	1.80	
Wausau	77	15	50.6	3.35	
Wewahitchka	80	15	49.4	3.84	
Georgia.					
Adairsville	67	7	39.6	10.00	T.
Albany	70	19	45.0	4.90	
Allapaha	78	15	46.0	3.24	
Allentown	78	12	46.6	4.26	0.5
Georgia—Cont'd.					
Alpharetta	71	5	39.4	7.84	2.2
Americus	70	10	43.0	3.78	
Athens *b*	.....	.....	.....	5.42	2.0
Bainbridge	74	19	49.0	2.93	
Blakely	73	...	.....	2.25	
Bowersville	67	11	38.0	7.78	2.5
Brent	68	8	43.1	6.15	1.8
Camak	72	10	42.6	5.72	1.0
Canton	.....	.....	.....	10.89	0.7
Carlton	.....	.....	.....	6.17	1.3
Clayton	65	9	37.8	13.35	5.5
Covington	69	7	42.6	7.83	1.2
Dahlonega	65	6	39.7	10.94	3.5
Diamond	69	3	38 6	11.26	2.5
Dublin	.....	...	.....	4.43	.....
Elberton	67	11	43.0	7.18	2.2
Experiment	68	8	41.4	8.39	0.5
Fitzgerald	78	13	47.6	3.57	
Fleming	77	14	48.4	1.52	
Fort Gaines	72	14	46.0	2.89	
Gainesville	65	8	38.2	6.37	
Gillsville	70	8	40.6	6.14	2.5
Greenbush	68	3	38.7	10.59	3.4
Griffin	67	8	40.5	9.16	0.5
Harrison	74	10	46.1	3.64	2.0
Hawkinsville	75	13	44.6	4.22	
Hephzibah	76	10	45.7	3.72	1.0
Jesup	77	16	49.1	1.61	
Lost Mountain	70	6	40.6	10.17	2.0
Louisville	75	10	45.4	3.86	2.5
Lumpkin	73	10	46.6	5.01	
Marshallville	71	11	45 0	5.65	T.
Mauzy	79	14	49.9	3.52	
Milledgeville	71	10	40.9	5.90	2.0
Millen	78	11	47.2	5.07	2.7
Morgan	74	12	45.2	4.13	
Naylor	78	16	49.8	1.70	
Newnan	67	8	38.2	6.68	.....
Oakdale	.....	.....	.....	5.46	T.
Point Peter	69	10	39.9	6.86	3.0
Poulan	79	13	47.5	4.23	
Putnam	71	11	45.6	5.61	
Quitman	75	15	48.8	2.39	
Ramsey	66	5	41.0	10.32	1.0
Resaca	.....	.....	.....	11.22	0.2
Rome	69	7	38.9	10.58	2.0
Statesboro	75	14	48.0	2.56	
Talbotton	70	10	43.8	6.43	T.
Thomasville	75	16	51.2	2.43	
Toccoa	69	11	39.8	7.65	2.0
Valona	78	17	50.2	1.52	
Vidalia	78	15	46.5	1.44	
Washington	70	11	41.0	5.83	0.6
Waverly	80	17	50.6	1.20	
Waycross	77	12	48.1	1.63	
Waynesboro	75	11	46.1	1.40	2.2
Westpoint	71	9	42.4	11.13	0.5
Woodbury	70	9	41.0	6.90	0.7
Idaho.					
Albion	62	4	31.9	2.54	8.0
American Falls	56	— 6	29.3	2.37	10.5
Blackfoot	53	0	28.1	1.25	T.
Burnside	41	.....	.....	1.45	1.5
Chesterfield	46	—17	20.2	1.68	3.0
Downey	46	0	24.6	0.46	3.2
Forney	46	—20	19.7	2.44	16.0
Garnet	59	17	37.2	0.92	.....
Grangeville	53	— 5	24.4	0.85	7.5
Hailey	50	— 3	23.8	0.95	9.2
Lake	46	—18	21.4	2.90	29.0
Lakeview	50	16	32.2	2.30	0.5
Lost River	48	— 3	22.0	0.98	6.8
Moscow	51	8	31.2	3.10	5.8
Murray	44	9	28.8	5.22	30.0
Ola	52	8	32.1	3.74	6.2
Payette	60	16	35.4	2.94	0.5
Pollock	52	20	34.8	1.96	1.0
Porthill	42	12	29.6	1.34	
Priest River	46	9	30.8	2.15	10.5
Riddle	56	— 8	29.8	1.44	2.5
St. Maries [4]	47	14	34.0	3.18	4.6
Soldier	50	—13	24.0	0.41	4.8
Swan Valley	51	4	23.8	1.80	14.0
Vernon	43	0	23.8	0.60	6.0
Weston	51	— 2	27.6	1.25	1.2
Illinois.					
Albion	61	—10	28.5	5.70	3.0
Aledo	52	—15	23.0	0.91	1.2
Alexander	63	—18	26.0	2.15	4.5
Antioch	53	—14	21.6	0.90	1.0
Ashton	55	—16	21.8	0.99	5.4
Astoria	60	—14	25.3	2.68	8.0
Aurora	57	—16	22.9	1.40	5.8
Benton	64	—10	29.9	4.00	5.5
Bloomington	60	—13	25.0	3.08	3.7
Bushnell	57	—14	24.6	1.50	1.5

TABLE II.—*Climatological record of voluntary and other cooperating observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Illinois—Cont'd.	°	°	°	*Ins.*	*Ins.*
Cambridge	54	−12	22.6	1.16	3.0
Carlinville	61	−14	27.5	4.54	4.6
Centralia	65	−11	30.2	4.08	7.6
Charleston	.....	.....	.....	3.17	6.0
Chemung	.....	−14	.....	1.73	.....
Chester	.....	.....	.....	1.92	6.0
Cisne	66	− 9	30.2	4.84	6.5
Coatsburg	60	−19	24.8	2.27	5.0
Cobden	65	−10	30.8	5.68	6.0
Danville	60	−13	25.9	2.84	0.4
Decatur	62	−15	25.8	4.43	6.4
Dixon	52	−14	22.8	1.13	2.5
Dwight	58	−14	24.2	2.54	2.0
Effingham	63	− 9	27.8	3.00	3.5
Equality	64	− 9	30.6	3.53	7.0
Flora	63	− 9	29.5	5.18	9.0
Friendgrove [#3]	60	− 8	29.8	5.72	3.1
Galva	57	−15	22.4	1.09	3.8
Grafton	.....	.....	.....	3.88	6.8
Grayville	58	− 8	29.1	4.64	3.7
Greenville	63	−16	27.4	3.68	5.0
Griggsville	68	−16	27.3	2.82	.....
Halfway	62	−10	30.4	5.21	4.7
Halliday	65	−11	31.6	3.33	3.8
Havana	59	−15	25.7	0.73	1.0
Henry	60	−15	24.9	1.76	6.0
Hillsboro	60	−13	26.7	3.66	5.3
Joliet	57	−13	23.2	2.36	9.3
Kishwaukee	53	−15	22.0	1.53	2.0
Knoxville	51	−16	23.0	0.89	2.7
Lagrange	58	−14	23.2	1.33	5.0
Labarpe	55	−17	23.6	0.69	3.8
Lanark	42	−17	21.8	1.26	2.2
Loami	.....	.....	.....	2.77	3.5
McLeansboro	63	−10	30.2	5.20	5.5
Martinsville	.....	.....	.....	4.39	5.5
Martinton	58	−17	24.5	3.10	4.5
Mascoutah	64	−15	28.4	3.53	6.2
Mattoon	68	− 7	31.4	3.63	1.6
Melrose	61	−11	27.0	3.93	6.0
Minonk	58	−15	23.6	1.87	6.0
Monmouth	54	−16	22.4	0.78	1.6
Monticello	61	−17	25.4	1.05	3.5
Morgan Park	.....	.....	.....	2.29	7.2
Morrison	50	−15	22.6	1.36	2.7
Morrisonville	59	−13	26.3	3.97	6.0
Mount Carmel	.....	.....	.....	6.07	10.5
Mount Pulaski	60	−15	25.2	2.47	5.2
Mount Vernon	65	− 2	30.4	4.05	8.0
New Burnside	66	−10	32.7	4.85	.....
Olney	64	− 8	29.2	5.16	10.2
Ottawa	59	−12	25.9	2.09	4.5
Palestine	60	− 7	27.6	5.34	6.7
Pana	63	−12	26.9	3.16	1.5
Paris	60	−11	25.8	3.54	2.0
Peoria [a]	.....	.....	.....	2.18	.....
Peoria [b]	59	−10	26.5	2.26	3.7
Philo	60	−14	25.1	3.75	2.5
Plumhill	63	−15	28.6	4.23	7.5
Rantoul	61	−13	26.0	3.49	2.7
Raum	63	−13	29.8	4.33	10.0
Riley	54	−16	21.2	1.22	4.0
Robinson	62	− 8	27.8	5.18	8.5
Rushville	61	−16	24.9	1.75	4.9
St. Charles [#5]	55	−15	23.2	1.19	5.2
St. John	64	−15	30.3	3.24	3.0
Scales Mound	47	−16	20.8	1.60	1.0
Shobonier	63	−14	28.6	3.24	4.0
Strawn [c]	58	−15	24.0	2.64	2.0
Streator	59	−13	24.8	2.15	.....
Sullivan	61	−14	26.0	3.11	2.5
Sycamore	54	−14	22.4	1.30	4.0
Tilden	64	−17	27.6	3.59	8.0
Tiskilwa	55	−14	22.6	1.41	3.5
Tuscola	60	−13	25.8	3.73	4.1
Walnut	55	−14	24.0	1.25	2.3
Wellington	58	−14	25.8	2.13	T.
Winchester	64	−15	26.2	2.53	4.0
Winnebago	55	−16	21.4	2.05	4.0
Yorkville	60	−17	23.2	1.23	1.4
Zion	48	−15	20.6	0.35	T.
Indiana.					
Anderson	61	−11	26.4	5.34	9.4
Angola	58	−13	24.8	3.47	2.8
Auburn	62	−12	25.6	1.57	.....
Bedford	67	− 9	31.2	3.05	3.1
Bloomington	62	−10	28.6	4.75	7.0
Bluffton	62	−12	26.0	4.01	7.5
Butlerville	65	−13	29.4	4.93	5.6
Cambridge City	65	−17	24.0	4.01	6.9
Columbus	64	−15	28.4	3.97	6.0
Connersville	65	−18	26.6	3.74	9.1
Crawfordsville	58	−10	26.2	2.50	3.0
Delphi	63	−12	25.8	3.80	2.5
Edwardsville [#1]	65	−10	31.7	4.23	3.9
Farmland	61	−10	25.8	4.65	13.2
Indiana—Cont'd.	°	°	°	*Ins.*	*Ins.*
Franklin [#1]	63	− 8	27.9	4.41	8.2
Greencastle	60	−11	26.6	4.27	7.2
Greensburg	65	−12	28.4	4.04	11.0
Hammond	48	−15	22.8	4.15	7.0
Hector	60	−12	25.7	3.35	10.0
Huntington	60	− 8	25.2	3.58	7.5
Jeffersonville	67	− 7	31.6	4.39	3.5
Knightstown	63	−12	27.6	4.80	4.7
Kokomo	62	− 9	26.6	2.10	3.0
Lafayette	61	−11	26.0	3.46	2.4
Laporte	61	−12	25.1	2.83	8.5
Logansport	61	−12	25.0	3.49	T.
Madison [a]	67	−10	29.5	4.01	6.0
Madison [b]	.....	.....	.....	3.87	.....
Marengo	64	−19	29.1	4.51	4.2
Marion	62	−12	25.6	3.94	8.0
Markle	64	−13	25.2	2.97	7.0
Mauzy	61	−16	25.5	4.01	11.0
Mount Vernon	64	− 8	29.2	4.07	5.7
Northfield	60	−13	24.9	3.19	3.0
Paoli	64	−18	29.8	4.67	6.3
Prairie Creek	61	− 9	28.0	4.00	5.0
Princeton	62	− 8	28.2	3.75	10.0
Rensselaer	58	−15	26.3	3.51	4.0
Richmond	63	−16	26.8	3.85	3.0
Rockville	60	−12	25.5	3.46	5.0
Salem	64	−17	29.6	4.57	6.8
Scottsburg	65	− 9	30.6	4.47	6.5
Seymour	63	−11	28.0	4.67	7.8
South Bend	60	−15	24.4	3.50	11.0
Syracuse	58	−13	24.1	4.48	8.5
Terre Haute	60	− 7	27.7	4.18	5.2
Topeka	58	− 9	24.4	2.91	2.0
Valparaiso	58	−14	22.9	1.84	.....
Veedersburg	62	−12	27.8	3.20	.....
Vevay	68	− 5	32.6	3.85	6.0
Vincennes	64	− 6	28.0	5.85	3.5
Washington	61	− 9	28.2	5.22	10.0
Winamac	59	−19	23.8	4.76	1.3
Worthington	62	− 8	26.8	5.01	9.5
Indian Territory.					
Ardmore	76	8	42.5	1.17	
Bengal	74	3	38.6	2.75	0.5
Chickasha	74	0	39.6	1.41	1.2
Durant	80	6	44.0	1.01	
Fairland [f]	64	− 3	34.0	2.47	T.
Hartshorne	74	5	44.0	1.83	
Healdton	73	4	41.6	0.68	T.
Holdenville	71	3	39.8	2.72	
Marlow	72	0	39.2	1.42	4.0
Muscogee	70	5	40.1	1.78	T.
Pauls Valley	70	2	39.4	1.25	T.
Roff [d]	70	4	40.4	2.50	
Ryan	81	6	44.6	0.53	
South McAlester	.....	.....	.....	1.86	T.
Tahlequah	72	1	38.0	2.68	1.0
Tuisa	.....	.....	.....	1.81	
Webbers Falls	70	5	37.4	1.59	0.8
Iowa.					
Afton	52	−17	21.8	1.00	8.0
Albia	58	−18	21.8	1.58	7.6
Algona	45	−24	18.4	0.78	7.8
Alta	42	−26	17.2	0.89	8.3
Amana	44	−17	20.6	1.59	2.0
Ames	52	−19	20.5	0.57	4.2
Atlantic	46	−25	20.7	0.60	6.0
Audubon	45°	22°	19.2°	1.67	4.8
Baxter	47	−19	20.0	0.38	1.5
Belknap	.....	.....	.....	2.75	8.5
Belleplaine	.....	.....	.....	1.45	6.5
Bonaparte	48	−15	22.8	1.30	1.0
Britt	42	−27	16.2	0.27	3.7
Buckingham	.....	.....	.....	0.93	2.8
Burlington	54	−14	24.5	0.91	1.9
Bussey	.....	.....	.....	1.40	5.0
Carroll	50	−20	21.0	0.50	5.0
Cedar Rapids	48	−16	21.4	1.76	3.5
Charlton	52	−16	22.1	1.51	4.5
Charles City	40	−23	15.8	0.32	2.5
Clarinda	51	−19	23.4	0.75	7.0
Clearlake	56	−26	21.8	0.32	3.2
Clinton	50	−12	22.4	0.88	1.0
College Springs	52	−19	22.7	0.85	3.5
Columbus Junction	50	−14	22.0	1.96	3.2
Corning	46	−19	21.4	1.18	8.5
Council Bluffs	49	−15	23.4	0.68	9.6
Cumberland	.....	.....	.....	0.80	8.0
Danville	.....	.....	.....	1.72	T.
Decorah	43	−24	18.0	0.30	3.8
Delaware	41	−21	19.4	1.07	4.5
Denison	45	−21	19.2	0.86	3.6
Desoto	49	−16	22.8	0.95	8.2
Dows	48	−23	18.2	0.55	5.0
Eldon	48	−16	22.4	1.78	3.8
Elkader	46	−21	19.3	0.61	2.0
Emerson	.....	.....	.....	0.30	.....
Iowa—Cont'd.	°	°	°	*Ins.*	*Ins.*
Estherville	46	−30	14.9	0.57	5.4
Fairfield	43[d]	−16[d]	20.8[d]	.....	.....
Fayette	40	−24	17.1	0.70	4.4
Fonda	.....	.....	.....	0.64	5.5
Forest City	46	−28	17.4	0.60	6.0
Fort Dodge	50	− 22	20.0	0.20	2.0
Fort Madison	.....	.....	.....	1.42	4.0
Galva	48[b]	−25[c]	19.8[c]	0.65	6.5
Gilman	.....	.....	.....	0.45	T.
Glenwood	54	−16	23.2	0.90	8.5
Grand Meadow	45	−25	17.5	0.64	1.5
Greene	46	−23	18.3	0.21	.....
Greenfield	46	−22[a]	20.1[c]	0.89	7.7
Grinnell	49	−18	20.2	1.47	9.6
Grinnell (near)	48	−19	20.0	0.84	6.5
Grundy Center	47	−25	17.8	0.83	3.0
Guthrie Center	54	−19	21.7	0.79	5.5
Hampton	50	−22	19.0	0.43	3.1
Harlan	47	−22	19.6	0.90	9.0
Hopeville	49	−17	21.4	.....	.....
Humboldt	56	−24	20.2	0.40	3.0
Independence	45	−22	18.3	0.48	4.8
Indianola	64	−19	21.0	2.07	8.8
Iowa City	45	−16	21.8	2.34	2.5
Iowa Falls	41	−22	17.4	0.65	6.5
Jefferson	.....	.....	.....	0.57	4.2
Keosauqua	54	−14	23.8	1.81	2.0
Knoxville	53	−17	22.6	1.69	7.5
Lacona	.....	.....	.....	1.50	8.0
Larrabee	43	−26	19.0	0.76	7.6
Leclaire	.....	.....	.....	1.32	0.2
Lemars	48	−31	20.4	0.55	5.5
Lenox	51	−23	21.2	0.74	6.4
Logan	50	−20	21.5	1.10	11.0
Maple Valley	.....	.....	.....	0.85	8.5
Maquoketa	52	−15	23.6	1.54	.....
Marshalltown	47	−20	20.8	0.87	4.5
Monticello	44	−18	20.8	1.27	1.0
Mountayr	52	−19	21.4	1.24	11.0
Mount Pleasant	48	−17	21.1	0.23	1.3
Mount Vernon [b]	44[f]	−14	22.2[d]	1.88	3.6
New Hampton	42	−25	16.0	0.05	0.5
Newton	52	−22	19.6	1.32	9.6
Northwood	44	−25	17.6	0.77	7.8
Odebolt	48	−21	20.5	0.54	6.3
Ogden	50	−22	21.2	1.30	5.0
Olin	44[b]	−17[c]	23.2[c]	1.82	2.2
Onawa	49	−18	21.4	1.07	11.2
Osage	40	−24	17.0	0.40	4.0
Oskaloosa	49	−17	21.4	1.70	6.0
Ottumwa	50	−14	24.8	0.68	3.5
Ovid	50	−18	22.2	1.79	5.8
Pacific Junction	50	−21	22.8	0.67	6.3
Perry	46	−18	21.0	0.95	7.9
Plover	46°	−27	18.8°	0.27	2.7
Redoak	58	−13	27.0	0.71	6.3
Ridgeway	44	−26	18.9	1.15	5.6
Rockwell City	50	−20	20.7	0.28	2.7
Ruthven	.....	.....	.....	0.57	5.8
Sac City	48	−22	18.4	0.68	6.8
St. Charles	63	−18	22.5	1.31	6.6
Scranton	47	−12	22.8	0.10	1.0
Sheldon	48	−27	17.5	0.83	8.3
Sibley	47°	−29°	16.1°	0.65	6.5
Sigourney	49	−16	22.1	1.89	4.0
Sioux Center	46	−27	18.3	0.70	7.0
Spirit Lake	48	−22	18.7	0.65	6.5
Storm Lake	44	−27	17.0	0.62	6.6
Thurman	48	−27	22.2	0.88	8.5
Toledo	59	−19	21.3	.....	.....
Villisca	54	−20	24.0	1.15	11.0
Vinton [#1]	41°	−17°	19.6°	0.25	2.5
Wapello	53	− 9	24.5	1.35	2.2
Washington	.....	.....	.....	1.68	.....
Washta	.....	.....	.....	0.80	8.0
Waterloo	45	−21	19.0	0.59	2.5
Waverly	42[d]	−17[d]	19.6[d]	0.58	5.3
Westbend	47°	−25	17.6°	0.60	6.0
Wilton Junction	52	−14	22.5	2.14	3.0
Woodburn	.....	.....	.....	1.30	2.5
Kansas.					
Abilene	62	− 7	30.9	0.10	T.
Achilles	71°	−17°	28.7°	0.44	4.5
Altoona	.....	− 6	.....	1.75	1.5
Anthony	.....	.....	.....	0.30	0.0
Atchison	54	− 9	26.5	0.98	4.8
Baker	67	−13	25.6	0.25	
Beloit	62	−11	28.6	0.20	2.0
Burlington	69	− 6	30.7	1.27	0.5
Chanute	68	− 6	33.2	0.94	T.
Colby	74	−16	30.1	0.26	3.0
Columbus	62	− 5	31.8	2.46	2.8
Coolidge	75	−10	30.5	0.05	0.5
Delphos	65	−11	29.8	0.08	0.8
Dresden	69	−14	30.0	0.51	5.1
Ellinwood	66	− 8	30.5	0.53	4.8

TABLE II.—*Climatological record of voluntary and other cooperating observers.*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Kansas—Cont'd.	°	°	°	*Ins.*	*Ins.*
Emporia	58	— 6	31.3	0.40	1.0
Englewood	75	— 5	35.0	0.10	0.5
Eureka	.....	.....	.....	1.64	T.
Eureka Ranch	69	—12	29.6	0.55	5.5
Fallriver	60	— 4	32.5	0.90	T.
Farnsworth *1	67	— 3	31.0	0.25	2.0
Fort Leavenworth	60	— 9	29.2	0.95	2.0
Fort Scott	72	— 6	31.6	1.68	5.5
Frankfort	59	—11	28.6	0.27	2.8
Gar 'en City	68	— 8	32.6	0.31	0.9
Gove *1	75	— 8	31.2	0.40	4.0
Grenola	62	— 5	31.6	0.88	1.0
Hanover	59	—10	27.5	0.11	1.1
Harrison	64	—12	28.2	0.05	0.6
Hays	67	— 6	32.9	0.70	7.0
Horton	54	—12	26.6	0.69	3.5
Hoxie	69	—11	30.4	0.60	6.0
Hutchinson	66	— 9	31.3	0.25	1.5
Independence	58	— 4	32.4	1.73	2.3
Jetmore	73	— 7	33.1	0.24	0.8
Lakin	70	—10	32.8	0.08	1.0
Lawrence	54	— 6	29.1	1.56	4.0
Lebanon	62	—13	26.6	0.20	2.0
Lebo	56	— 6	29 1	1.08	1.8
Leoti	75	— 9	30.0	0.20	2.0
Little River	64	— 9	30.4	0.51	1.0
Macksville	66	— 7	31.7	0.37	.....
McPherson	65	— 7	30 3	0.61	....
Madison	60	— 6	30.4	0.86	.....
Manhattan	61	— 6	30.5	0.31	1.1
Marion	57	— 6	31.0	0.80	3.0
Medicine Lodge	68	— 4	33.4	T.	T.
Minneapolis	67	—10	29.8	0.05	0.5
Moran	55	— 6	31.6	1.59	0.8
Mounthope *1	63	— 6	32.1	0.38	0.5
Ness City	68	— 3	34.0	0.48	3.0
Newton	64	— 7	30.4	0.23	0.6
Norwich	65	— 7	33.4	0.25	T.
Oberlin	.....	.....	.....	0.70	6.0
Olathe	60	— 9	29.6	1.97	3.5
Osage City	59	— 7	29.4	1.32	2.2
Osborne	.....	.....	.....	T.	T.
Oswego	63	— 5	33.2	2.30	.....
Ottawa	55	— 8	29.0	1.46	3.4
Phillipsburg	69	— 4	28.7	T.	T
Pratt	79	— 6	34.1	0.22	2.0
Rome	65	— 5	32.5	0.15	T.
Salina	65	— 9	30.0	0.16	1.0
Sedan	60	— 8	31.2	0.88	3.0
Seneca	62	—10	28.0	0.50	3.1
Toronto	68	— 6	29.0	1.43	1.8
Ulysses	72	—12	31.6	0.15	1.0
Valley Falls	60	—10	28.2	0.70	4.6
Viroqua	75	—12	35.1	0.10	1.0
Wakeeney (near)	.....	.....	.....	0·55	5.5
Wallace	.....	.....	.....	0.30	3.0
Wamego *1	55	— 7	28.6	0.30	1.5
Winfield	60	— 4	32.9	0.58	T.
Yates Center	57	— 7	29.3	1.21	2.8
Kentucky.					
Alpha	69	— 3	36.6	5.69	5.6
Anchorage	69	—12	31.0	4.41	2.5
Bardstown	66	— 7	32.2	5.27	2.5
Berea	69	—10	32.6	5.26	1.5
Blandville	65	— 7	30.8	6.54	11.2
Bowling Green	64	—10	29.5	5.60	.....
Burnside	70	— 7	33.8	5.03	3.8
Carrollton	68	— 8	30.8	1.56	2.5
Catlettsburg	61	— 3	33.0	4.41	4.0
Centertown	67	—15	31.4	4.36	4.5
Earlington	67	—10	31.6	5.61	8.8
Edmonton	66	—14	32.8	4.80	11.0
Eubank	67	—14	33.2	3.79	4.0
Falmouth	.....	.....	.....	4.75	2.0
Frankfort	.....	.....	.....	2.80	.....
Franklin	65	— 6	33.3	2.90	5.8
Georgetown	68	—10	31.9	.....	.....
Greensburg	69	—12	31.0	4.35	3.1
Henderson	62	— 8	31.1	5.67	9.5
Hopkinsville	67	—14	33.3	5.40	7.2
Irvington	63	—13	30.2	3.86	4.0
Leitchfield	65	—11	30.4	5.25	4.6
Loretto	68	—11	32.4	4.43	1.3
Manchester	.....	—11	.....	4.78	9.0
Marrowbone	67	—15	32.4	3.92	8.5
Maysville	70	— 9	30.4	4.35	3.7
Mount Sterling	66	— 6	31.8	5.15	3.0
Owensboro	66	— 8	32.8	4.85	5.5
Owenton	.....	—10	.....	5.49	3.5
Paducah *a*	.....	.....	.....	6.74	9.0
Paducah *b*	67	— 3	34.0	7.58	8.5
Pikeville	71	2	35.8	6.38	8.2
St. John	65	—12	31.2	4.95	2.6
Scott	67	—10	29.6	4.07	3.8
Shelby City	67	—15	29.4	4.82	4.2
Shelbyville	67	—10	31.8	5.02	3.5

Stations.	(Fahrenheit.) Temperature. Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Kentucky—Cont'd.	°	°	°	*Ins.*	*Ins.*
Warfield [f]	72	3	36.3	6.73	7.5
Williamsburg	66	— 3	35.8	7.79	10.4
Louisiana.					
Abbeville	78	18	51.2	9.00	T
Alexandria	78	15	46.7	8.92	8.0
Amite	79	12	47.8	8.50	3.0
Baton Rouge	80	16	48.8	9.03	
Burnside	80	15	50.8	5.97	6.5
Calhoun	79	11	43.2	3.61	
Cameron	76	21	51.4	5.20	T.
Cheneyville	78	15	47.1	7.55	0.5
Clinton	77	14	49.4	11.83	1.0
Collinst n	78	12	43.7	5.19	T.
Covington	82	14	49.2	5.07	5.0
Donaldsonville	81	18	62.6	6.55	8.0
Emilie	76	19	50.0	5.65	3.0
Farmerville	70	10	41.1	4.66	
Franklin	80	20	50.6	4.95	2.0
Grand Coteau	77	18	51.0	5.47	T.
Hammond	78	15	50.0	5.34	5.0
Houma	80	18	50.9	5.37	0.1
Jennings	79	19	50.9	4.70	
Lafayette	77	18	49.0	8.02	
Lake Charles	78	21	50.6	6.04	
Lake Providence	85	9	47.8	6.15	T.
Lakeside	75	21	50.0	4.98	3.2
Lawrence	81	21	52.1	5.27	
Libertyhill	77	13	46.7	3.00	T.
Mansfield	77	14	43.6	4.61	
Melville	83	10	48.0	8.30	T.
Minden	75	15	43.6	4.48	
Monroe	77	11	44.5	5.89	
Opelousas	78	19	49.1	8.48	
Oxford	75[b]	15[b]	44.2[b]	3.11	
Paincourtville	79	17	49.1	5.48	8.0
Plain Dealing	74	11	44.0	2.50	0.5
Prevost	.....	.....	.....	3.27	T.
Rayne	79	17	48.9	6.36	
Robeline	76	14	47.6	.....	
Ruddock	75	17	50.4	6.55	2.5
Ruston	77[f]	12[f]	48.6[f]	3.64	0.8
Schriever	82	16	50.4	4.23	12.0
Sugar Ex. Station	78	21	50.3	4.98	
Sugartown	74	20	49.0	6.57	
Venice	83	26	54.4	2.90	
Wallace	80	17	51.6	6.16	4.0
White Sulphur Springs	85	15	48.2	9.92	2.0
Maine.					
Bar Harbor	55	2	28.4	9.78	16.5
Belfast	55	— 2	24.7	9.74	22.0
Calais	52	— 5	24.0	8.07	21.0
Cornish	53	— 8	24.4	7.52	21.5
Fairfield	54	—15	23.2	7.98	20.5
Farmington	51	—18	22.6	8.97	28.0
Flagstaff	55	—26	20.2	4.88	33.0
Gardiner	54	—10	25.2	9.43	13.8
Kineo	43	— 5	19.0	7.40	22.5
Lewiston	54	— 8	25.4	7.59	20.0
Mayfield	50	1	23.1	8.63	26.0
North Bridgton	52	— 8	25.4	5.75	17.0
Orono	55	—17	23.2	7.94	21.5
Rumford Falls	50	—14	21.3	5.53	20.5
Winslow	57	—30	21.4	8.23	19.5
Maryland.					
Annapolis	60	10	35.0	6.15	T.
Bachmans Valley	60	2	30.2	11.18	1.5
Boettcherville	70	— 2	29.8	6.12	3.0
Boonsboro *a*	65	4	32.4	6.49	2.0
Cambridge	67	13	37.8	5.31	0.2
Charlotte Hall [d]	66	2	33.8	4.10	1.5
Chase	59	3	31.8	7.39	T.
Cheltenham	66	0	33.0	6.38	0.6
Chestertown	74	11	33.4	7.44	T.
Chewsville	65	.....	.....	5.83	2.5
Clearspring	65	5	30.3	6.14	2.0
Coleman	.....	.....	.....	5.81	
Collegepark	67	2	31.6	6.70	.....
Colora	.....	.....	.....	8.44	2.0
Cumberland *b*	.....	.....	.....	6.32	
Darlington	66	5	32.4	8.41	1.0
Deerpark	64	—13	26.5	4.39	5.0
Easton	68	9	35.6	5.76	0.5
Fallston	61	7	32.7	8.14	1.0
Frederick	66	4	34.1	6.81	2.2
Grantsville	64	— 8	28.0	6.87	6.5
Greatfalls	66	2	30.7	8.06	.....
Greenspring Furnace	66	3	31.0	5.29	2.0
Guard	64	— 6	29.4	5.47	2.5
Harney	.....	.....	.....	6.66	2.0
Jewell	65	7	35.2	5.52	T.
Johns Hopkins Hospital	67	8	31.4	8.78	.....
Laurel	66	3	31.4	8.48	.....
Longwoods	.....	.....	.....	6.56	T.
Mount St. Marys Coll	65	6	31.2	6.39	0.3
Newmarket	64	5	32.2	7.46	1.2
Pocomoke	66	10	38.5	4.15	0.8

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melte snow.	Total depth of snow.
Maryland—Cont'd.	°	°	°	*Ins.*	*Ins.*
Princess Anne	67	7	36.8	5.67	0.5
Queenstown	68	12	34.6	5.69	0.5
Rockhall *b*	66	8	33.9	6.71	T.
Sharpsburg	67	1	31.9	6.98	1.8
Smithsburg *a*	65	3	31.6	6.09	1.0
Smithsburg *b*	.....	2	.....	8.71	2.6
Solomons	64	14	36.6	5.46	0.6
Sudlersville	70	9	34.9	7.00	T.
Sunnyside	65	—15	26.4	8.57	12.0
Takoma Park	66	4	31.9	7.95	0.1
Taneytown	65	4	32.0	5.62	4.0
Van Bibber	65	7	32.4	7.24	.....
Westernport	64	1	28.9	5.92	2.2
Woodstock	66	4	34.0	9.29	0.8
Massachusetts.					
Amherst	56[f]	—10[f]	28.0[f]	8.51	16.0
Bedford	61	— 2	27.6	8.00	13.5
Bluehill (summit)	62	5	29.8	7.88	8.2
Cambridge	64	1	31.0	8.24	.....
Chestnuthill	64	0	30.7	8.25	6.2
Cohasset	.....	.....	.....	8.49	.....
Concord	61	— 4	27.8	7.47	13.0
East Templeton *1	59	— 1	26.1	8.11	23.8
Fallriver	61	9	33.8	9.57	9.5
Fitchburg *a* *1	58	— 2	27.4	8.46	21.5
Fitchburg *b*	60	— 4	27.6	8.30	20.8
Framingham	61	— 5	28.6	10.57	2.0
Groton	58	—11	25.8	8.65	27.0
Hyannis	.....	.....	.....	8.48	9.3
Jefferson	.....	.....	.....	9.35	19.8
Lawrence	61	— 3	27.9	8.68	18.8
Leominster	.....	.....	.....	8.81	23.8
Lowell *a*	60	— 2	28.4	8.55	.....
Lowell *b*	60	— 4	28.5	.....	.....
Ludlow Center	58	—11	23.6	8.35	12.0
Middleboro	64	— 6	30.6	8.70	5.4
Monson	62	—14	27.2	10.06	18.0
New Bedford *a*	61	5	33.6	10.05	7.0
Pittsfield	60	—13	25.8	7.07	27.0
Plymouth *1	60	9	34.4	10.20	.....
Princeton	.....	.....	.....	9.46	19.0
Provincetown	53	14	34.0	7.62	6.8
Salem	.....	.....	.....	7.37	9.8
Somerset *1	68	0	33.1	8.60	7.5
Springfield Armory	63	— 4	28.8	8.82	12.6
Sterling	.....	.....	.....	8.84	20.0
Webster	.....	.....	.....	9.43	9.0
Westboro	62	— 3	31.1	6.95	11.0
Weston	62	— 4	29.8	7.81	9.0
Williamstown	66	—12	25.2	4.63	24.6
Winchendon	.....	.....	.....	7.98	25.5
Worcester	63	5	29.4	7.41	12.0
Michigan.					
Adrian	59	—10	24.4	2.91	2.0
Agricultural College	57	—10	21.6	3.00	5.8
Allegan	58	— 8	25.2	2.00	5.0
Alma	55	—10	22.2	2.40	7.0
Ann Arbor	59	—10	23.6	3.05	10.2
Annpere	.....	.....	.....	1.50	7.0
Arbela	58	—10	24.2	2.86	3.0
Baldwin	47	— 9	23.2	2.20	11.0
Ball Mountain	54	— 8	23.6	4.26	8.0
Battlecreek	58	—10	24.0	3.31	5.3
Bay City	55	— 8	21.8	1.90	4.0
Benzonia	43	0	24.1	3.99	30.9
Berlin	54	— 8	24.0	3.97	11.9
Berrien Springs	60	—13	25.0	4.35	16.0
Big Rapids	52	— 7	21.4	2.08	5.0
Birmingham	52	—10	22.2	1.95	4.0
Boon	41	—14	19.8	2.27	9.0
Calumet	36	— 6	19.2	2.48	31.0
Carsonville	50	—10	23.5	1.50	2.5
Cassopolis	59	—16	23.8	3.29	2.3
Charlevoix	45	0	25.1	3.58	20.8
Chatham	39	—20	18.6	4.93	49.3
Cheboygan	41	— 5	21.6	2.30	6.0
Clinton	60	—12	24.2	2.82	6.0
Coldwater	59	—11	24.0	3.25	6.5
Deerpark	39	—11	20.7	5.68	57.0
Detour	40	— 3	22.1	3.05	27.0
Dundee	60	—10	24.8	3.86	5.8
Eagle Harbor	41	— 2	22.5	1.70	17.0
East Tawas	45	— 4	23.4	2.07	4.5
Eloise	60	—11	24.8	3.76	8.3
Ewen	38	—25	17.4	1.30	13.0
Fairview	56	—10	23.6	2.32	11.0
Fennville	57	—13	24.6	3.03	16.5
Fitchburg	58	—15	23.2	3.60	10.5
Flint	58	— 7	23.8	2.40	6.0
Frankfort	.....	.....	.....	2.67	19.0
Gaylord	38	—15	19.0	1.95	6.5
Gladwin	53	—10	22.3	1.95	3.5
Grand Rapids	55	— 7	24.4	2.38	9.0
Grape	62	—11	23.8	3.54	5.3
Grayling	49	—17	19.8	2.05	14.5
Hanover	60	—10	24.4	3.39	6.3

TABLE II.—*Climatological record of voluntary and other cooperating observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Michigan—Cont'd.	°	°	°	*Ins.*	*Ins.*
Harbor Beach	55	— 3	24.8	1.15	7.5
Harrison	51	— 6	20.7	1.82	2.0
Harrisville	44	— 5	22.2	1.31	5.3
Hart	40	1	23.4	3.91	19.5
Hastings	58	—11	23.4	2.60	5.5
Hayes	55	— 8	22.3	1.57	2.0
Highland Station	.....	.....	.....	2.72	7.0
Hillsdale	58	—12	22.8	3.12	8.5
Humboldt	40	—28	14.8	0.30	2.0
Ionia	55[e]	—10	24.4[e]	1.92	5.2
Iron Mountain	30[c]	—21[c]	16.6[c]	0.58	5.7
Ironwood	38	—26	14.8	2.28	22.8
Ishpeming	37	—18	16.4	2.00	20.0
Ivan	41	— 7	20.4	2.11	12.5
Jackson	59	— 7	24.6	2.64	7.0
Jeddo	53	— 6	23.6	3.70	7.6
Kalamazoo	56	—11	24.6	3.00	4.0
Lake City	41	— 8	18.3	1.30	3.0
Lansing	58	— 8	22.8	2.90	6.8
Lapeer	57	—11	22.9	1.28	.....
Lathrop	35	—22	17.7	5.95	59.5
Lincoln	45	— 6	21.6	1.30	3.0
Ludington	47	— 2	25.4	1.90	12.6
Mackinac Island	42	2	22.6	2.23	20.0
Mackinaw	40	— 5	21.6	1.83	7.0
Mancelona	40	—12	20.8	2.37	14.2
Manistee	46	— 4	23.3	4.06	31.5
Manistique	41	—10	22.0	0.99	5.0
Menominee	40	—16	20.8	0.30	3.0
Midland	54	— 5	24.6	1.77	9.0
Mio	45	— 8	20.0	1.43	8.5
Mount Clemens	59	4	23.3	3.45	13.5
Mount Pleasant	45	— 5	20.2	1.39	2.0
Muskegon	49	— 3	25.6	1.22	7.0
Newberry	40	—10	19.1	0.92	9.0
North Marshall	53[s]	—11[s]	19.6[s]	.....	.....
Old Mission	45	3	23.8	2.39	12.0
Olivet	56	—10	23.0	3.86	7.1
Omer	55	—10	23.4	1.43	4.0
Onaway	40	—11	20.9	1.63	4.0
Ontonagon	40	—12	18.8	4.83	48.0
Ovid	56	—10	23.0	3.17	5.0
Owosso	53	— 9	23.2	2.75	8.0
Petoskey	42	— 3	23.0	1.95	9.5
Plymouth	.....	.....	.....	2.02	9.0
Pontiac	56	— 8	24.0	3.20	12.0
Reed City	49	— 5	22.4	1.52	8.5
Roscommon	.....	.....	.....	1.40	8.0
Saginaw	57	— 8	23.8	2.51	8.9
St. Ignace	42	— 5	23.0	3.10	17.0
St. Johns	57	— 9	23.8	1.71	6.5
St. Joseph	58	.....	.....	3.96	19.0
Sidnaw	38	—19	12.6	0.78	4.8
South Haven	51	0	25.6	3.01	11.0
Stanton	55	—10	21.4	1.66	5.0
Thornville	54	— 6	24.4	3.01	15.5
Traverse City	40	— 6	24.4	2.50	23.5
Vassar	49	—10	23.5	1.94	4.6
Wasepi	58	—10	23.6	3.65	11.0
Waverly	.....	.....	.....	4.35	28.0
West Branch	46	— 7	21.8	1.85	3.9
Wetmore	46	—19	18.6	2.80	28.0
Whitecloud	50	1	24.5	1.35	3.5
Whitefish Point	40	— 2	22.1	2.20	22.0
Ypsilanti	52	—10	24.0	2.98	9.0
Minnesota.					
Ada	36	—42	7.6	0.74	10.0
Albert Lea	39	—27	13.2	0.27	3.2
Alexandria	46	—36	14.0	0.21	1.8
Ashby	41	—33	12.5	0.96	9.6
Beardsley	45	—31	15.8	0.30	3.0
Bemidji	40	—35	12.0	0.48	.....
Bird Island	41	—27	14.5	0.15	1.5
Blooming Prairie	41	—31	12.2	0.45	4.5
Brainerd	43[c]	—35[c]	10.4[c]	0.57	5.7
Caledonia	40	—26	15.9	0.36	4.6
Collegeville	45	—27	15.4	0.38	6.4
Crookston	41	—31	11.2	0.76	8.0
Currie	57	—27	14.2	.....	.....
Deephaven	.....	.....	.....	0.28	6.1
Detroit City	37	—48	7.8	0.74	9.0
Faribault	43	—29	14.8	0.51	4.9
Farmington	48	—30	15.2	0.60	6.0
Fergus Falls	35	—35	11.8	0.93	9.3
Glencoe	50	—30	14.6	0.20	T.
Grand Meadow	37	—30	12.4	0 84	9.0
Hallock	38	—36	8.8	0.56	4.8
Hovland	.....	.....	.....	0.67	5.5
Lakeside	47	—32	13.8	0.40	4.0
Lake Winnibigoshish	37	—31	10.8	0.60	7.5
Leech	45	—33	11.2	0.57	7.4
Long Prairie	44	—37	9.6	0.70	5.8
Luverne	44	—26	17.7	0.38	3.0
Mapleplain	43	—31	13.8	0.86	8.9
Milan	45	—34[d]	12.6[d]	0.67	6.8
Minneapolis[b1]	40[e]	—28	14.7	0.54	6.0
Minnesota—Cont'd.					
Montevideo	44	—29	14.4	0.44	5.5
Morris	38	—32	13.2	0.45	4.5
Mount Iron	35	—35	7.0	0.57	5.8
New London	44	—31	13.3	0.35	3.0
New Richland[e1]	42	—30	16.0	.....	.....
New Ulm	47	—26	15.8	0.43	6.0
Park Rapids	40	—39	10.4	0.77	7.7
Pine River	42	—35	13.0	0.79	8.0
Pipestone	41	—26	14.8	0.10	1.0
Pleasant Mounds	42[e]	—26[e]	16.7[e]	0.42	5.8
Pokegama Falls	39	—47	7.4	0.64	9.8
Redwing *a*	.....	.....	.....	0.61	5.2
Redwing *b*	39	—25	16.0	0.49	8.5
Reeds	.....	.....	.....	0.42	10.0
Rolling Green	44	—24	15.8	0.91	9.0
St. Charles	41	—32	14.0	1.05	6.5
St. Cloud	47	—32	14.8	0.23	3.0
St. Peter	46	—27	16.7	0.28	6.2
Sandy Lake Dam	42	—39	10.0	0.58	5.8
Shakopee	41	—27	15.4	0.84	8.5
Tower	35	—42	6.4	0.95	9.5
Two Harbors	40	—26	12.6	0.50	5.5
Wabasha	41	—27	16.2	0.66	8.2
Warroad	36	—37	6.5	0.40	4.0
Willmar	40	—33	13.6	0.40	3.0
Willow River	46[d]	—35[c]	14.3[d]	0.84	10.3
Winnebago City	41[i]	—26	18.4[e]	1.08	13.8
Worthington[f]	49	—36	14.4	0.51	6.5
Zumbrota[1]	40[e]	—34	15.8	.....	.....
Mississippi.					
Aberdeen	70	8	39.0	4.79	T.
Agricultural College	70	6	40.8	5.32	T.
Austin	71	3	39.7	5.76	4.2
Batesville	73	1	38.4	5.07	
Bay St. Louis	73	19	48.2	7.32	T.
Biloxi	71	18	50.0	6.84	
Booneville	65	1	35.9	6.26	T.
Brookhaven	76	10	43.2	8.45	
Canton	77	11	44.6	9.84	0.2
Columbus *a*	.....	.....	.....	6.41	
Columbus *b*	71	8	39.2	6.41	
Crystalsprings	76	12	43.4	10.10	
Edwards	75	12	45.4	9.00	T
Fayette	76	14	45.1	11.70	T.
Fayette (near)[e1]	77	18	48.4	9.73	
Greenville *a*	75	9	43.0	4.92	0.5
Greenville *b*	76	9	41 4	4.71	0.5
Hattiesburg	73	15	46.6	5.47	T.
Hazlehurst	77	.....	.....	8.76	T.
Hernando	72	1	36.4	.....	.....
Holly Springs	66	0	34.8	3.26	1.0
Indianola	76	9	42.9	5.42	0.5
Jackson	77	12	43.4	10.83	T.
Lake	73	9	40.2	7.83	T.
Louisville	72	5	42.0	7.77	T.
Magnolia	77	12	47.8	10.43	1.5
Natchez	78	11	46.9	8.10	
Nittayuma	76	11	42.4	6.25	T.
Okolona	72	3	37.0	4.39	T.
Palo Alto	73	6	41.8	5.63	T.
Pearlington	76	15	48.5	5.74	T.
Pittsboro	69	3	40.2	5.63	
Pontotoc	70	2	39.4	5.86	0.7
Poplarville	75	23	51.0	5.87	0.2
Port Gibson	77	14	46.4	10.35	
Ripley	67	0	36.6	6.63	3.0
Shoccoe	.....	.....	.....	7.72	0.6
Stonington[e1]	78	14	46.2	9.16	T.
Suffolk	75	11	47.4	9.61	T.
Swartwout	77	16	50.4	6.04	
Thornton	72	14	44.2	10.56	T.
Tupelo	.....	.....	.....	5.47	
University	69	2	39.6	7.80	2.0
Walnutgrove	74[c]	10[c]	42.3[c]	7.75	T.
Watervalley	77	4	41.0	6.23	T.
Waynesboro	74	12	48.5	7.90	T.
Woodville	75	15	47.8	9.68	
Yazoo City	77	11	42.2	7.85	T.
Missouri.					
Appleton City	61	—14	29.8	0.82	5.5
Arthur	67	—17	29.6	1.74	4.0
Avalon	65	—21	26.0	2.26	6.5
Bethany	53	—29	23.6	1.71	7.0
Birchtree	64	—13	32.2	3.48	3.5
Boonville	.....	.....	.....	3.18	8.4
Brunswick	49	—22	25.0	1.87	6.5
Conception	56	—22[d]	24.0	1.26	7.0
Darksville	55	—22	25.0	1.92	9.2
Dean	70	— 5	35.5	4.68	3 0
Desoto	66	—15	30.8	3.67	5.0
Downing	.....	.....	.....	1.88	4.5
Edgehill[e5]	56	—18	28.2	3.65	4.8
Eightmile[e3]	.....	— 9	28.7	1.27	3.4
Eldon	67	—24	29.4	3.75	15.0
Fairport	.....	.....	....	1.45	7.8
Fayette	59	—21	26.4	3.17	8.5
Missouri—Cont'd.					
Fulton	64	—18	28.4	3.57	12.0
Galena	.....	.....	.....	2.96	1.6
Gallatin[e1]	50	—24	25.2	2.36	10.0
Gayoso	63	— 5	34.4	5.63	4.2
Glasgow	55	—20	26.2	3.09	7.5
Gorin	.....	.....	.....	1.35	2.7
Halfway	71[c]	—15[c]	31.6[c]	4.05	8.3
Harrisonville	56	—15	26.8	1.09	3.1
Hazlehurst	.....	.....	.....	3.01	12.5
Hermann	.....	.....	.....	3.58	1.1
Houston	64	—12	32.0	4.56	3.7
Irena	.....	.....	.....	1.74	10.0
Ironton	65	—16	29.7	4.36	7.5
Jackson	65	—24	31.0	5.33	5.5
Jefferson City	65	—24	27.7	3.85	9.5
Kidder	52	—21	24.0	2.72	10.8
Koshkonong	67	— 9	33.6	4.19	3.2
Lamar	64	— 9	33.0	2.02	.....
Lamonte	.....	.....	.....	1.70	4.5
Lebanon	70	—15	30.6	4.66	11.0
Lexington	64	—13	28.8	1.94	5.0
Liberty	52	—14	26.9	1.81	6.0
Louisiana	59[c]	—22	29.2[d]	3.58	4.7
McCune[e1]	63	—23	26.4	2.93	12.3
Macon	56	—21	25.9	1.71	7.5
Marblehill	65	—20	30.8	3.95	9.5
Marshall	60	—22	27.0	2.58	6.8
Maryville	49	—13	22.0	1.65	10.0
Mexico	63	—21	27.0	2.53	6.8
Miami[e5]	46	—14	26.4	2.34	9.7
Mineralspring	65	— 6	34.2	1.60	2.0
Monroe City	63	—20	25.6	2.95	5.8
Montreal	65	—25	29.0	4.02	11.5
Mountaingrove	63	—14	30.4	3.53	3.3
Mount Vernon	68	— 7	35.5	6.11	6.0
Neosho	67	— 7	34.7	4.49	6.0
Nevada	.....	.....	.....	1.97	6.5
New Haven	65	—16	30.0	4.17	12.0
New Madrid *b*	.....	.....	.....	6.72	.....
New Palestine	61	—16	30.6	1.72	3.0
Oakfield	63	—16	29.1	5.01	11.5
Olden	66	—10	32.5	4.04	2.5
Oregon *a*	51	—12	25.4	1.68	9.0
Palmyra[e5]	54	—16	26.9	2.17	5.2
Phillipsburg[e1]	59	—14	29.9	4.24	7.5
Pine Hill	.....	.....	.....	4.52	7.0
Poplarbluff	.....	— 2	.....	2.68	.....
Potosi	64	—26	28.1	5.32	10.0
Princeton	47	—17	24.3	2.15	11.1
Richmond	49	—14	26.3	2.43	7.5
Rockport	.....	.....	.....	1.37	9.0
Rolla	.....	.....	.....	4.80	10.0
St. Charles	64	—19	28.8	4.21	6.2
St. Joseph	.....	.....	.....	1.37	5.5
Sarcoxie[e3]	.....	—12	26.5	3.86	6.0
Sedalia	63[h]	—17	30.5[i]	1.48	5.5
Seymour	62	—13	30.6	3.60	5.5
Sikeston	67	— 8	33.1	4.70	6.5
Steffenville	55	—19	25.8	1.93	9.7
Sublett[b]	50	—19	21.4	1.39	8.5
Trenton	57	—14	25.1	2.43	10.2
Unionville	49	—16	24.2	2.60	5.5
Warrensburg	57	—14	28.4	1.64	4.5
Warrenton	63	—17	26.1	5.06	10.0
Wheatland	.....	.....	.....	3.80	9.0
Windsor	60	—18	29.0	1.34	4.0
Zeitonia	63	—17	31.6	4.93	8.0
Montana.					
Adel	47	—25	25.2	3.10	28.0
Anaconda	52	— 8	26.6	2.26	12.4
Augusta	.....	—12	.....	0.65	8.0
Billings	59	—22	28.0	.....	.....
Boulder	47	—14	26.8	1.17	9.5
Bozeman	43	—12	25.1	1.46	.....
Butte	46	— 6	26.8	1.70	17.0
Canyon Ferry	48[e]	—10	25.8[e]	1.20	17.1
Chester	51	—22	22.2	0.60	6.0
Columbia Falls	43	0	27.8	3.25	12.5
Crow Agency	56	—28	28.4	0.45	3.5
Culbertson	43	—29	16.7	0.29	2.5
Deerlodge	.....	—22	.....	1.09	11.0
Dillon	48	—15	26.8	2.49	15.8
Fort Logan	46	—30	21.6	1.50	14.0
Glasgow	46	—12	22.2	0.64	6.4
Glendive	46	—31	19.6	1.50	15.0
Greatfalls	54	—10	31.9	0.53	4.4
Lewistown	52[j]	—21[b]	26.1[f]	2.25	22.5
Livingston	65	2	30.5	1.12	8.2
Manhattan	61	—23	24.0	1.14	11.2
Martinsdale	48	—18	23.6	1.60	16.0
Marysville	45	— 4	24.6	3.45	25.5
Missoula	50	— 4	22.5	2.23	17.0
Ovando	42	—18	20.6	3.15	19.2
Parrot	53	—13	28.1	0.79	6.0
Plains	48	8	30.0	1.90	5.0
Poplar	46	—24	19.2	0.60	6.0

TABLE II.—*Climatological record of voluntary and other cooperating observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Montana—Cont'd.	°	°	°	*Ins.*	*Ins.*
Ridgelawn	44	−29	18.2	1.20	12.0
St. Pauls	48	−17	25.3	0.87	10.2
St. Peter	47	−20	27.0	1.28	17.4
Toston	57	−16	22.9	.....	.....
Townsend	52	−19	21.2	1.02	11.0
Troy	47	9	30.3	1.91	T.
Twinbridges	50	− 8	26.2	.....	.....
Utica	57	−18	28.6	3.22	32.5
Yale	52	−22	25.8	1.70	17.0
Nebraska.					
Agate	.....	.....	.....	0.70	4.6
Agee *1	48	−28	18.8	0.91	9.1
Albion	61	−27	22.8	1.00	10.0
Alliance	70	−32	26.9	0.90	9.0
Alma	68	−18	27.9	0.11	1.1
Ansley	64	−28	24.0	0.29	2.9
Arapahoe	.....	.....	.....	0.10	1.0
Arborville *1	56	−18	23.6	0.20	2.0
Arcadia	.....	.....	.....	0.76	.....
Ashland *a*	51	−16	23.0	0.28	2.0
Ashland *b* *1	50	−15	23.5	0.65	6.5
Ashton	.....	.....	.....	0.18	2.0
Auburn	59	−19	25.6	0.71	6.1
Aurora	60	−23	24.8	0.29	1.0
Bartley	.....	.....	.....	0.26	3.0
Beatrice	60	−14	25.6	0.32	3.2
Beaver	69	−20	29.0	0.11	1.0
Bellevue	.....	.....	.....	0.72	9.9
Benedict	.....	.....	.....	0.29	2.9
Benkleman	.....	.....	.....	0.80	8.0
Blair	66	−21	21.2	0.76	11.9
Bluehill *1	50	−15	24.7	0.07	0.5
Bradshaw	.....	.....	.....	0.14	1.6
Brokenbow	63	−27	24.8	0.10	0.5
Burwell	.....	.....	.....	0.95	9.5
Callaway	50	−28	20.9	0.67	6.0
Camp Clarke	67	−35	26.4	1.18	11.8
Chester	.....	.....	.....	0.13	1.3
Cody	.....	.....	.....	0.70	7.0
Columbus	53	−18	22.8	0.42	5.0
Crete	57	−14	25.4	0.26	3.1
Cuibertson	.....	.....	.....	0.41	4.0
Curtis	64[h]	−25[h]	24.0[h]	0.20	2.0
David City	52	−17	20.6	1.20	11.0
Dawson	62	−15	27.7	0.53	4.0
Eden	.....	.....	.....	0.70	6.0
Edgar *a* *5	58	−15	25.8	T	T.
Ericson	.....	.....	.....	0.48	4.8
Ewing	.....	.....	.....	0.65	5.0
Fairbury	62	−15	25.4	0.15	1.2
Fairmont	59	−15	23.2	0.20	2.0
Fort Robinson	60	−28	26.4	0.89	7.7
Fremont	52	−20	22.0	0.90	9.0
Fullerton	.....	.....	.....	0.45	4.8
Geneva	57	−15	23.5	0.21	2.1
Genoa	50	−28	22.2	0.70	7.5
Gering	64	.....	.....	1.54	15.0
Gordon	.....	.....	.....	0.60	6.0
Gosper	.....	.....	.....	0.08	1.2
Gothenburg	62	−27	25.6	0.25	2.5
Grand Island *a*	.....	.....	.....	0.21	2.3
Grand Island *b*	63	−17	25.1	0.29	3.2
Grand Island *c*	60	−15	24.4	.....	.....
Greeley	.....	.....	.....	0.27	2.7
Guide Rock	.....	.....	.....	0.02	0.2
Haigler	.....	.....	.....	0.50	5.0
Hartington	50	−24	18.8	1.50	15.0
Harvard	60	−17	25.0	0.17	1.7
Hastings *1	60	−13	26.0	0.28	3.1
Hayes Center	.....	.....	.....	0.35	0.5
Hay Springs	55	−38	23.7	0.98	6.8
Hebron	60	−14	26.4	0.19	1.7
Hickman	.....	.....	.....	0.45	4.5
Holbrook	.....	.....	.....	0.25	3.0
Holdrege	.....	.....	.....	0.30	3.0
Hooper *1	46	−20	21.3	0.73	14.3
Imperial	63	−30	28.0	0.85	11.0
Johnstown	.....	.....	.....	0.85	11.0
Kearney	67	−17	26.6	0.10	.....
Kimball	58	−24	26.7	1.55	15.5
Kirkwood *1	49[l]	−26	21.0[d]	1.17	10.2
Laclede	59	−18	24.1	0.39	3.1
Lexington	62	−26	26.2	0.65	6.0
Lodgepole	64[l]	−30[l]	27.0[l]	1.10	11.0
Loup	67	−26	23.4	0.31	4.0
Lynch	59	−33	20.0	0.60	6.0
Lyons	.....	.....	.....	0.80	8.0
McCook *1	70	−12	28.8	0.25	2.5
McCool	.....	.....	.....	T.	T.
Madison	52	−23	21.6	1.00	11.3
Madrid	.....	.....	.....	0.30	3.0
Marquette	.....	.....	.....	0.36	3.3
Mason City	.....	.....	.....	0.45	4.5
Minden *a*	67	−18	25.8	0.18	2.2
Monroe	.....	.....	.....	0.46	5.5
Nebraska City *b*	.....	.....	.....	0.60	5.0
Nemaha *1	66	−10	28.6	0.52	5.2
Nesbit	64	−31	25.2	0.20	4.0
Norfolk	50	−29	20.1	0.59	8.3
North Loup	65	−26	23.8	0.36	3.6
Oakdale	58	−29	19.2	0.68	6.4
Odell	.....	.....	.....	0.20	2.0
O'Neill	67	−50	20.2	0.91	9.0
Ord	.....	.....	.....	0.55	5.5
Palmer	.....	.....	.....	0.35	3.0
Palmyra *1	54	−14	24.0	0.41	5.5
Plattsmouth *b*	55	−19	23.7	0.64	.....
Ravenna *a*	68	−20	25.0	0.33	3.3
Ravenna *b*	.....	.....	.....	0.15	1.5
Redcloud *b*	68	−14	26.6	0.15	1.5
Republican *1	60	−16	26.3	0.10	1.0
Rulo	.....	.....	.....	0.55	2.5
St. Libory	.....	.....	.....	0.27	2.7
St. Paul	66	−18	26.4	0.23	2.5
Salem *1	58	−20	26.2	0.67	.....
Santee	58	−24	22.0	1.13	10.7
Schuyler	.....	.....	.....	0.52	.....
Seneca *1	52	−30	25.5	0.50	5.0
Seward	67	−16	23.6	0.17	1.7
Smithfield	.....	.....	.....	0.10	1.0
Spragg	.....	.....	.....	0.99	11.2
Springview	52	−30	21.6	0.90	9.0
Stanton	52	−26	20.9	0.81	10.0
State Farm	57	−14	25.5	0.55	7.5
Strang *1	55	−12	28.0	0.07	0.7
Stratton	.....	.....	.....	0.73	6.0
Superior	.....	.....	.....	0.16	.....
Syracuse	.....	.....	.....	0.70	7.0
Tecumseh *b*	67	−18	24.3	.....	.....
Tecumseh *c*	.....	.....	.....	0.54	4.9
Tekamah	51	−22	21.6	2.04	19.5
Turlington	54	−16	24.4	0.70	8.0
Wakefield	50	−24	19.8	0.71	7.1
Wallace	.....	.....	.....	0.30	3.0
Wauneta	.....	.....	.....	0.70	7.0
Weeping Water	.....	.....	.....	0.77	9.6
Westpoint	55	−24	23.5	0.84	7.0
Whitman	.....	.....	.....	0.60	6.0
Wilber *1	56	−12	26.0	0.10	.....
Willard	.....	.....	.....	0.20	3.0
Wilsonville	.....	.....	.....	0.32	3.2
Winnebago	.....	.....	.....	0.65	8.2
Wisner	.....	.....	.....	0.75	9.3
Wymore	.....	.....	.....	0.30	.....
Nevada.					
Amos	60	7	31.1	0.59	
Austin	55	− 2	31.5	0.40	
Belmont	54	2	30.4	0.16	1.0
Beowawe *1	60	8	32.6	1.50	7.0
Candelaria	74	6	41.5	T.	T.
Carson City	67	10	36.6	1.23	T.
Cranes Ranch	.....	.....	.....	1.57	6.1
Elko *1	54	8	27.5	1.47	4.0
Elko (near)	56	5	32.1	2.39	5.0
Ely	58	0	30.2	0.72	6.5
Fenelon *1	60	0	30.4	0.30	3.0
Golconda *1	65	16	38.9	1.14	2.0
Halleck *1	54	8	31.3	1.10	1.0
Hamilton	46	1	24.8	0.95	9.5
Hawthorne	67	6	36.6	0.20	2.0
Hot Springs *5	68	16	37.2	T.	T.
Humboldt *1	60	14	33.5	0.15	0.5
Lee	.....	.....	.....	2.30	13.5
Lewers Ranch	65	9	38.4	3.97	1.0
Lovelocks *a* *1	67	3	37.0	.....	.....
Lovelocks *b*	60	6	33.2	0.45	1.5
Martins	69	8	37.4	0.39	.....
Mill City *1	57	8	33.7	0.52	0.2
Monitor Mill	.....	− 7	.....	0.33	3.3
Owyhee	58	−10	30.4	1.20	6.0
Palisade *1	64	0	29.2	0.80	8.0
Palmetto	68	− 5	35.1	T.	T.
Reno State University	56	8	35.2	0.45	2.3
Silverpeak	.....	.....	.....	0.00	
Tecoma *1	60	10	37.8	0.50	
Toano *5	51	3	29.3	1.12	5.5
Tybo	55	7	33.8	0.15	2.0
Verdi *1	58	4	32.2	0.10	1.0
Wadsworth *1	62	8	30.6	0.30	
Wells	49	− 1	29.6	0.92	4.0
Woods	59	−19	27.3	2.45	5.0
New Hampshire.					
Alstead	58	− 9	24.5	7.26	28.8
Bethlehem	58	− 5	22.4	4.66	27.0
Brookline *1	58	−12	26.5	6.05	26.5
Chatham	54	−14	22.8	8.40	32.0
Concord	58	−23	24.4	7.20	28.3
Durham	58	− 6	28.0	7.62	25.5
Franklin Falls	56	−11	24.8	7.05	29.0
Grafton	57	−23	22.8	6.63	28.0
Keene	61	−22	24.5	6.70	28.8
Littleton	58	−11	20.0	4.51	27.0
New Hampshire—Cont'd	°	°	°	*Ins.*	*Ins.*
Nashua	60	−10	25.4	7.61	26.8
Newton	59	− 6	26.6	7.29	19.0
Peterboro	59	−23	24.2	7.94	30.0
Plymouth	55	−18	22.1	6.20	31.8
Sanbornton	57	− 9	24.2	5.93	22.0
Stratford	62	−20	21.7	4.42	24.0
New Jersey.					
Asbury Park	64	9	34.4	6.66	3.5
Bayonne	61	10	32.7	6.91	0.8
Belvidere	65	4	29.8	7.31	2.0
Bergen Point	61	10	32.2	7.43	1.0
Beverly	68	1	33.1	8.06	2.1
Blairstown	65	2	28.4	.....	
Bridgeton	64	7	34.9	6.94	T.
Camden	64	7	33.9	9.11	0.5
Cape May C. H.	63	6	35.2	5.32	T.
Charlotteburg	60	2	29.9	9.45	2.0
Chester	67	1	33.2	8.18	6.7
Clayton	65	4	33.6	6.28	0.5
College Farm	67	6	32.6	7.30	T.
Dover	62	3	29.6	7.42	2.0
Egg Harbor City	63	− 5	33.4	7.98	8.0
Elizabeth	63	8	32.4	8.20	2.5
Englewood	57	13	32.6	6.71	0.5
Flemington	65	5	31.4	7.60	1.3
Freehold	64	7	32.8	6.81	1.5
Friesburg	64	5	33.4	6.56	0.5
Hanover	65	3	30.8	7.56	1.1
Hightstown	66	7	33.2	7.03	1.0
Imlaystown	66	5	34.6	6.60	0.8
Indian Mills	65	− 3	34.2	7.04	5.0
Lakewood	64	0	33.9	7.46	3.0
Lambertville	64	7	32.1	7.19	1.8
Layton	63	− 8	26.8	8.56	T.
Mount Pleasant	.....	.....	.....	7.31	5.5
Newark	62	10	31.8	7.58	0.3
New Brunswick	65	7	33.0	7.85	1.0
New Egypt	.....	.....	.....	5.35	
Newton	63	3	28.4	7.52	4.0
Oceanic	61	7	33.8	7.26	2.0
Paterson	62	11	33.6	8.24	1.0
Perth Amboy	59	8	31.6	6.77	0.8
Plainfield	66	5	32.0	7.39	0.4
Rancocas	.....	.....	.....	7.90	3.8
Rivervale	63	0	31.0	6.90	1.0
Roseland	62	7	30.2	7.71	0.8
Salem	65	8	34.8	8.19	0.2
Somerville	67	5	32.2	7.75	T.
South Orange	62	9	31.6	7.57	1.0
Sussex	64	0	29.2	6.94	9.0
Three Bridges	.....	.....	.....	8.23	1.5
Toms River	66	−12	31.9	8.46	9.0
Trenton	67	12	35.6	7.54	T.
Tuckerton	63	− 5	33.5	8.37	6.0
Vineland	66	4	34.4	6.60	1.0
Woodbine	63	1	31.6	6.55	2.0
Woodstown	.....	.....	.....	7.89	.....
New Mexico.					
Alamagordo	68	15[c]	42.9	0.10	0.5
Albert	75	1	39.7	0.05	1.0
Albuquerque	69	13	37.4	T.	T.
Alma	70	8	39.1	0.13	
Arabela	75	.....	.....	0.30	3.0
Aztec	62	−12	26.6	0.40	4.0
Bellranch	.....	.....	.....	T.	T.
Bluewater	60	− 1	30.6	0.20	2.0
Cambray	.....	.....	.....	0.00	
Carlsbad	85	9	46.8	0.20	2.0
Cloudcroft	52	− 4	27.0	1.70	17.0
Deming	.....	.....	.....	T.	T.
East Lasvegas	63	8	35.6	0.30	3.0
Engle	71	16	40.3	0.00	
Folsom	66	−10	29.8	0.43	6.2
Fort Bayard	69	15	40.6	T.	T.
Fort Stanton	69[l]	− 1[l]	35.0[l]	0.95	8.0
Fort Union	70	0	36.2	0.20	2.0
Fort Wingate	69	− 3	34.6	0.17	2.5
Gage	.....	.....	.....	0.00	
Gallisteo	59	10	33.0	0.00	
Gallinas Spring	71	5	37.4	0.40	4.0
Horse Springs	64	5	35.1	0.10	1.0
Las Vegas	70	1	33.8	0.19	3.0
Las Vegas Hotsprings	71	− 1	35.4	0.17	1.7
Lordsburg	.....	.....	.....	T.	T.
Lower Penasco	70	14	44.3	T.	T.
Mesilla Park	74	11	42.8	0.05	0.5
Raton	65	− 6	32.7	0.55	5.5
Roswell	77	− 3	40.4	0.26	3.0
San Marcial	72	14	41.3	T.	T.
Socorro	66	18	39.4	0.01	0.2
Springer	76	−11	34.0	0.17	1.7
Strauss	.....	.....	.....	0.00	
Taos	56	− 5	28.4	0.40	4.0
Winsor Ranch	60	− 1	29.7	0.15	.....
Woodbury	66	5	34.8	0.00	

TABLE II.—*Climatological record of voluntary and other cooperating observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
New York.	°	°	°	*Ins.*	*Ins.*
Adams	.....	.....	.....	6.39	32.0
Addison	63	— 6	26.9	4.86	16.2
Adirondack Lodge	58	—14	19.6	3.02	24.7
Akron	.....	.....	.....	4.63	.....
Alden	64	0	27.4	3.29	14.0
Alfred	60	0	23.7	4.32	18.2
Angelica	60	— 13	23.8	4.77	18.0
Appleton	66	2	28.1	3.78	13.1
Athens	.....	.....	.....	6.45	19.6
Atlanta	61	— 8	24.0	4.82	16.0
Auburn	64	3	27.4	3.81	12.0
Avon	62	— 4	25.4	3.54	12.0
Axton	59	—16	20.0	2.54	7.9
Baldwinsville	65	1	27.6	5.48	15.8
Bedford *a*	60	5	30.4	8.28	0.7
Blue Mountain Lake	.....	.....	.....	5.60	10.0
Bolivar	60	—11	23.9	5.27	12.8
Bouckville	69	— 2	25.0	4.50	13.5
Boyds Corners	.....	.....	.....	9.53	.....
Brockport	59	1	26.8	4.82	13.0
Caldwell	60	— 3	25.1	5.82	21.5
Canaan Four Corners	59	— 9	24.8	5.22	22.0
Canton	60	—12	21.6	5.51	8.5
Carmel	61	5	29.2	9.46	6.5
Carvers Falls	65	—17	22.4	5.02	17.0
Catskill	63[f]	— 1	29.4[d]	6.59	18.5
Cedarhill	62	—11	26.6	6.53	16.7
Cooperstown	62	—10	24.8	4.85	19.0
Cortland	.....	.....	.....	6.41	9.4
Cutchogue	60	4	33.6	10.39	8.5
Dekalb Junction	.....	.....	.....	4.08	9.5
Easton	.....	.....	.....	4.52	21.0
Elba	62	— 1	26.9	4.10	20.0
Elmira	65	1	27.6	5.22	17.0
Fayetteville	66	— 2	27.0	5.36	10.0
Franklinville	61	—13	23.8	5.87	15.7
Gabriels	59	—10	20.2	3.25	12.0
Gansevoort	.....	.....	.....	5.50	23.5
Glens Falls	65	— 5	25.5	5.82	21.8
Gloversville	60	—11	22.6	4.07	23.5
Greenwich	64	—11	25.0	4.48	17.1
Griffin Corners	61	—17	25.2	7.47	22.3
Haskinville	.....	.....	.....	4.05	20.3
Hemlock	60	2	27.2	2.01	12.5
Honeymead Brook	62	—10	27.2	5.80	14.5
Humphrey	57	— 7	23.4	5.97	21.3
Indian Lake	59	—16	21.2	3.11	18.8
Ithaca	64	— 1	26.0	5.76	20.7
Jamestown	62	— 8	27.0	4.84	7.6
Jay	.....	.....	.....	2.22	.....
Keene Valley	61[c]	— 8[c]	24.2[c]	4.08	9.5
King Ferry	.....	.....	.....	4.89	12.0
Littlefalls, City Res	70	— 4	23.3	3.95	13.5
Lockport	62	3	29.7	3.20	7.0
Lowville	59	— 4	22.6	5.97	11.0
Lyndonville	.....	.....	.....	3.89	.....
Lyons	64	4	29.3	3.70	11.0
Mayle	.....	.....	.....	3.17	16.0
Meredith	58	— 6	22.5	5.08	15.0
Middletown	63	0	28.8	6.74	12.4
Mohonk Lake	57	— 1	26.0	6.88	20.0
Moira	66	— 7	23.8	4.19	8.0
Newark Valley	.....	.....	.....	5.78	13.0
New Lisbon	64	—17	23.2	4.53	14.5
New Rochelle	60	2	31.0	4.88	T.
North Hammond	58	—10	24.6	2.76	8.4
North Lake	61	0	23.0	.....	.....
Number Four	58	—11	21.0	5.17	15.5
Nunda	63	— 4	27.6	5.18	13.5
Ogdensburg	65	— 10	23.4	2.07	7.1
Old Chatham	.....	.....	.....	5.58	25.2
Oneonta	65	—12	26.6	4.36	17.5
Oxford	63	— 7	25.0	6.21	15.6
Palermo	.....	.....	.....	3.22	.....
Penn Yan	64	4	27.4	3.89	15.3
Perry City	63	— 8	24.6	5.28	17.1
Plattsburg Barracks	59	0	24.4	1.50	6.5
Port Byron	58	0	26.8	5.48	16.0
Port Jervis	63	—11	28.0	7.99	12.5
Primrose	70	5	30.7	5.89	1.5
Redhook	.....	.....	.....	6.07	6.0
Richmondville	75	—13	26.8	3.83	14.5
Ridgeway	63	4	27.8	4.48	12.7
Rome	67	— 3	25.6	5.51	11.0
Romulus	65	5	27.8	2.59	13.2
Salisbury Mills	.....	.....	.....	6.99	.....
Saranac Lake (near)	59	—12	21.5	1.61	10.6
Setauket	62	9	34.2	9.43	5.0
Shortsville	62	1	26.8	2.44	12.5
Skaneateles	.....	.....	.....	5.21	.....
Southampton	56	7	33.2	8.11	9.3
South Berlin	.....	.....	.....	1.70	12.0
South Canisteo	60	— 1	25.2	4.66	11.2
Southeast Reservoir	.....	.....	.....	4.05	20.3
South Kortright	62	—23	25.2	5.75	18.2
South Schroon	61	— 8	22.3	4.42	21.6
Straits Corners	62[f]	—13[f]	25.0[b]	6.30	18.5
Ticonderoga	62	— 2	26.0	6.17	19.5
Volusia	60	— 4	25.8	4.48	17.0
Walton	64	—17	26.2	4.72	16.6
Wappingers Falls	63	— 7	28.5	6.03	15.0
Warwick	.....	.....	.....	5.63	.....
Watertown	65	— 9	25.8	5.43	.....
Waverly	64	— 4	26.8	6.61	12.0
Wedgwood	61	— 1	24.6	5.29	21.0
Wells	57	—11	23.0	6.03	19.2
West Berne	60	—20	26.0	2.90	25.5
West Chazy	58	— 6	23.6	.....	.....
Westfield *a*	62	3	30.2	4.64	9.2
Westfield *b*	60	— 1	27.6	5.18	.....
Westfield *c*	64	2	29.5	4.80	5.5
Windham	64	—20	26.6	6.52	19.0
Wolcott	.....	.....	.....	5.31	17.1
North Carolina.					
Abshers	67	4	35.4	11.05	4.0
Asheville	.....	.....	.....	8.77	2.3
Bryson City	.....	.....	.....	9.84	9.3
Chapelhill	72	9	38.8	4.56	
Cherryville	66	5	38.2	9.31	0.5
Currituck	.....	.....	.....	4.98	
Edenton	69	15	43.3	3.93	0.5
Fayetteville	76	10	43.8	5.34	T.
Goldsboro	83	13	41.5	5.41	
Greensboro	68	7	37.6	5.72	T.
Henderson	73	7	39.0	5.62	0.5
Hendersonville	75	— 2	36.6	12.51	2.7
Henrietta	73	6	38.6	8.94	1.8
Highlands	60	— 5	33.2	13.95	11.8
Horse Cove	60	3	36.2	15.16	7.2
Kinston	78	11	45.2	4.67	T.
Lenoir	67	— 9	32.8	8.43	8.1
Linville	58	— 5	30.8	13.66	7.0
Littleton	69	7	39.0	4.72	1.0
Louisburg	70	8	42.0	4.33	0.9
Lumberton	72	15	42.0	5.65	T
Marion	69	4	38.0	11.84	4.4
Marshall	63[e]	—2[d]	34.4[e]	8.66	6.3
Mocksville	69	3	37.4	6.49	1.5
Moncure	73	10	41.0	4.28	T.
Monroe	71	7	40.2	6.40	1.0
Morganton	68	— 4	37.0	6.38	6.5
Mountairy	66	6	34.1	8.89	4.0
Murphy	.....	.....	.....	8.48	4.8
Newbern	74	15	46.2	5.18	T.
Oakridge	68	2	36.8	7.13	3.0
Patterson *1	63	— 1	33.4	10.47	7.1
Pittsboro	72[f]	6[b]	35.0[c]	3.57	1.8
Reidsville	69[f]	5[f]	37.0[f]	5.73	2.3
Rockingham	73	11	41.2	5.45	T.
Roxboro	69	6	38.8	5.58	0.5
Salem	69	5	36.3	5.57	T.
Salisbury	70	9	37.4	8.08	1.0
Saxon	70	8	38.4	7.47	6.0
Settle	69	4	38.0	10.45	4.1
Sloan	76	11	45.7	5.09	T.
Soapstone Mount	71	1	37.6	6.03	2.5
Southern Pines *a*	75	10	44.3	4.86	T.
Southern Pines *b*	73	11	42.2	4.74	
Southport	71	16	47.2	7.18	0.4
Springhope *1	71	12	43.9	4.52	T.
Tarboro	79	10	43.8	5.11	0.2
Washington	74	13	47.8	5.18	0.2
Waynesville	64	— 3	36.0	9.56	3.1
Weldon *a*	71	12	38.6	5.45	T.
Weldon *b*	.....	.....	.....	5.68	T.
North Dakota.					
Amenia	39	—35	10.2	0.84	8.4
Ashley	44	—31	9.8	0.65	6.5
Berlin	40	—36	9.0	1.22	12.2
Buxton	43	—33	12.5	0.51	5.1
Cando	36[e]	—37[b]	8.8[e]	0.08	0.8
Churchs Ferry	40	—33	9.8	0.44	4.4
Coalharbor	40	—31	13.7	0.42	4.2
Devils Lake	38	—32	10.2	0.20	2.0
Dickinson	43	—35	16.2	1.25	11.0
Donnybrook	.....	.....	.....	0.55	5.5
Dunseith	39	—43	7.8	0.45	4.5
Edgeley	44	—29	15.1	0.98	9.5
Ellendale	40	—31	14.3	1.00	10.0
Falconer *1	41	—31	17.0	0.75	7.5
Fargo	36	.....	.....	0.28	.....
Forman	41	—33	13.6	1.20	12.0
Fort Yates	60	—26	17.0	0.66	6.6
Fullerton	47	—33	14.3	0.81	8.1
Gallatin	46	—38	10.9	0.48	4.8
Glenullin	48	—28	16.2	0.64	5.0
Grafton	40	—25	11.6	0.32	3.2
Hamilton	40	—33	11.6	0.87	8.7
Hannaford	45	—32	12.4	0.50	5.0
Jamestown	55	—31	10.2	1.33	13.3
Larimore	41	—35	10.2	0.40	4.0
McKinney	47	—33	11.0	0.50	5.0
Medora	46	—37	18.3	1.45	14.2
Melville	40	—30	13.8	0.40	4.0
Milton	37	—36	7.4	0.23	2.3
Minto	42	—33	9.8	0.27	2.7
Napoleon	35	—32	12.2	1.40	9.0
New England	46	—37	14.2	0.90	9.0
Oakdale	45	—27	18.6	1.25	12.5
Pembina	44	—36	8.6	0.47	4.7
Portal	39	—33	12.8	0.30	3.0
Power	41	—34	11.6	0.82	8.2
Steele	39	—34	14.3	1.10	11.0
University	48	—33	10.2	0.71	7.1
Valley City	61	—39	7.3	0.94	9.4
Wahpeton	43	—32	15.6	0.54	5.4
Willow City	40	—40	9.5	0.70	7.0
Ohio.					
Akron	64	— 8	27.5	3.63	9.5
Annapolis	63	—14	27.5	3.45	.....
Atwater	.....	.....	.....	3.71	3.5
Bangorville	65	—13	26.8	3.11	7.2
Bellefontaine	60	—10	27.0	3.35	2.0
Bement	.....	.....	.....	3.38	5.8
Benton Ridge	62[c]	—11[c]	22.2[c]	3.59	13.0
Bethany	64	— 8	30.3	3.40	2.0
Binola	.....	.....	.....	4.36	12.0
Bladensburg	65	—19	26.6	3.30	3.0
Bloomingburg	63	—11	27.4	4.20	3.0
Bowling Green	64	—12	24.8	4.21	10.5
Cambridge	67	—14	29.4	3.95	2.0
Camp Dennison	68	—15	29.1	3.74	3.6
Canaan	.....	.....	.....	4.03	8.8
Canal Dover	65	—15	28.2	3.74	3.5
Canton	63	— 6	28.5	3.66	6.6
Cardington	64	—15	26.4	3.12	6.5
Cedarville	.....	.....	.....	3.41	2.5
Celina	63	—14	24.6	3.58	10.0
Circleville	66	—10	29.4	4.30	3.0
Clarksville	66	—13	28.8	3.78	2.7
Cleveland *a*	65	— 5	29.0	4.84	8.9
Cleveland *b*	65	— 6	26.2	3.50	5.8
Clifton	65	—11	28.0	3.20	3.5
Coalton	70	—13	30.3	4.25	0.5
Colebrook	62	— 8	27.7	3.40	5.5
Dayton *a*	.....	.....	.....	2.97	1.0
Dayton *b*	65	—12	27.7	3.83	2.7
Defiance	64	—10	25.4	4.14	7.5
Delaware	66	—13	27.0	3.56	7.1
Demos	67	— 6	28.6	3.37	3.0
Elyria	64	—11	25.6	3.88	11.2
Findlay	65	—11	28.0	3.90	8.5
Frankfort	67	—14	28.6	4.35	1.5
Fremont	62	— 9	25.8	4.29	9.2
Garrettsville	65	—16	26.5	3.94	8.6
Granville	65	—16	27.9	3.49	2.0
Gratiot	65	—16	27.7	4.18	3.9
Green	69	— 7	32.0	3.94	1.1
Greenfield	65	— 7	29.8	4.20	2.5
Greenhill	65	—16	26.8	3.34	4.0
Greenville	63	—10	27.8	2.42	7.0
Hanging Rock	72	— 6	32.8	4.17	T.
Hedges	63	— 8	24.6	4.03	5.0
Hillhouse	65	—11	26.0	5.06	12.0
Hillsboro	62	—19	27.4	3.81	2.0
Hiram	63	—11	25.9	3.85	4.5
Hudson	64	—14	25.6	3.38	11.0
Jacksonboro	65	— 9	27.4	2.85	5.0
Killbuck	64	—11	27.4	2.51	5.5
Lancaster	66	—12	28.9	4.39	3.0
Leipsic	.....	.....	.....	4.43	5.0
Lima	69	— 9	27.9	2.98	10.0
Logan	69	—12	30.3	.....	.....
McConnelsville	69	—11	29.4	4.65	2.0
Manara	65	—15	27.9	4.36	2.0
Mansfield	.....	.....	.....	3.10	5.5
Marietta	68	— 3	32.1	4.61	3.5
Marion	65	— 9	27.3	3.53	5.0
Medina	64	—14	26.8	3.92	12.0
Milfordton	67	—16	28.2	4.75	4.0
Milligan	68	—18	28.7	4.25	3.0
Millport	65	—18	26.5	3.73	3.2
Montpelier	59	—12	23.9	3.10	4.0
Moorefield	65	—11	29.8	4.16	2.0
Napoleon	63	—10	26.4	3.02	4.7
New Alexandria	65	— 7	30.2	4.75	3.0
New Berlin	65	—10	27.9	3.61	4.0
New Bremen	62	—14	25.2	3.75	3.5
New Lexington	.....	.....	.....	3.92	1.2
New Paris	62	—13	26.8	3.88	5.0
New Richmond	68	— 8	30.9	3.84	3.6
New Waterford	64	—10	28.6	3.24	10.0
North Lewisburg	65	—18	25.9	3.30	4.5
North Royalton	64	—11	26.5	3.99	15.0
Norwalk	64	—13	26.3	3.46	8.5
Oberlin	64	—11	26.8	3.24	8.3
Ohio State University	65	—13	28.0	3.71	1.7
Orangeville	62	—13	27.0	3.50	4.5

TABLE II.—*Climatological record of voluntary and other cooperating observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Ohio—Cont'd.	°	°	°	*Ins.*	*Ins.*
Ottawa	63	−12	24.9	.	T.
Pataskala	65	−17	27.3	3.78	4.8
Philo	66	−10	29.8	3.72	2.0
Plattsburg	63	−12	26.6	3.06	T.
Pomeroy	69	− 8	32.4	3.52	3.7
Portsmouth *a*				4.39	1.0
Portsmouth *b*	71	− 2	33.4	4.39	2.0
Pulse				3.69	5.5
Red Lion				3.32	
Richfield				4.07	6.2
Richwood	64	−13	26.6	3.59	3.5
Ripley	67	−11	30.3	4 08	2.5
Rittman	65	−10	27.8	3.62	3.0
Rock				4.18	4.0
Rockyridge	65	−12	26.0	4.29	11.8
Rosewood				3.91	7.0
Shenandoah	62	−14	26.0	3.71	5.5
Sidney	63	−12	27.0	3.95	7.4
Somerset	71	− 8	30.7	4.10	3.8
Springfield				3.24	0.2
Strongsville				4.64	7.0
Swanton				3.88	3.1
Thurman	72	−11	32.5	3.85	4.0
Tiffin	63	− 8	26.6	4.06	11.8
Upper Sandusky	65	−11	26.8	3.89	9.0
Urbana	63	− 9	27.4	3.27	2.9
Vanwert	63	−10	25.0	4.64	10.0
Vickery	64	−10	25.2	3.43	8.5
Walnut				3.76	3.9
Warren	65	− 6	28.4	4.43	5.9
Warsaw	66	−16	28.3	3.64	2.0
Wauseon	63	−11	24.4	5.73	7.6
Waverly	73	−11	30.9	4.22	3.0
Waynesville	66	−10	27.8	3.55	2.0
Wellington	64	−11	27.3	2.58	6.0
Wooster	64	−11	27.0	3.47	6.2
Zanesville				4.17	2.2
Oklahoma.					
Arapaho	70	−10	35.8	0.14	
Beaver	74	− 4	38.6		
Blackburn	65	− 7	34.6	1.86	5.0
Burnett	73	2	37.9	1.48	2.5
Chandler	70	0	38.2	1.35	0.5
Clifton	77	1	37.5	1.98	0.3
Cloud Chief	70	− 2	39.2	0.40	3.3
Fort Reno	71	− 3	36.3	0.76	1.0
Fort Sill	74	1	40.0	0.80	5.0
Guthrie	69	− 3	37.0	0.76	5.3
Hennessey	74	− 7	37.2	0.40	2.0
Jenkins	74	− 5	36.8	0.10	T.
Kenton	80	−15	35.9	0.10	1.0
Kingfisher	76	− 3	37.3	0.51	2.5
Lyons	70	− 8	36.0	0.29	0.5
Newkirk	62	− 4	33.4	0.27	T.
Norman	71	1	37.2	1.05	1.8
Pawhuska	68	− 6	35.7	1.15	2.5
Perry	71	− 8	35.6	0.40	0.8
Sac and Fox Agency	71	0	37.8	1.67	2.0
Shawnee	72	0	39.1	1.13	
Stillwater	72[f]	− 2[f]	36.6[f]	1.44	2.0
Taloga	70	− 4	37.2	0.18	2.3
Waukomis		− 4		T.	T.
Weatherford	68	− 2	39.2	0.31	2.8
Woodward				0.00	
Oregon.					
Albany *a* [*1]	57	25	42.5	3.58	
Albany *b*				5.33	T.
Alpha	62	25	41.8	11.75	
Arlington	60			1.57	
Ashland *b*	64	19	38.5	3.36	
Aurora [*1]	57	30	42.8	3.61	
Aurora (near)	56	25	40.2	4.15	0.1
Bay City	62	25	44.3	12.42	
Beulah	54	2	29.8	2.23	6.0
Buckbutte	58	22	39.8	6.60	
Blalock	57	21	39.8	1.73	T.
Brownsville [*1]	62	28	43.6	6.37	
Bullrun	51	26	39.2	8.60	
Burns	52	11	31.2		
Cascade Locks	56	29	43.2	11.94	
Comstock [*1]	59	25	42.1	6.27	
Coquille				6.13	
Corvallis	58	25	40.2	5.08	0.2
Dayville	59	15	37.7	1.64	T.
Ella				1.72	
Eugene	62	23	40.6	4.95	
Fairview	58	26	41.4	9.61	
Falls City	55	22	39.2	9.61	
Forestgrove	56	23	40.2	4.82	T.
Gardiner	60	28	42.6	9.82	
Glenora	52	26	39.0	19.02	1.0
Grants Pass	64	18	38.3	4.33	
Hare	72	27	47.0	11.81	
Heppner	64	16	38.6	2.16	2.3
Hood River (near)	55	20	38.8	4.75	T.
Huntington	52	15	34.6	2.25	
Oregon—Cont'd.					
Jacksonville	56	18	37.2	4.13	1.0
Joseph	54	1	27.9	1.43	9.0
Junction City [*1]	58	30	43.4	4.50	
Kerby	70	18	39.2	8.07	1.0
Klamath Falls	53	10	32.6	2.29	10.1
Lafayette [*1]	57	25	40.5	3.38	
Lagrande	52	13	34.7	2.78	7.2
Lakeview	55	11	33.0	2.78	1.6
Lonerock	60	9	37.9	2.27	5.5
McMinnville	55	24	40.3	5.26	T.
Merlin [*1]	65	22	41.5	4.02	
Monroe	57	23	41.2	6.38	
Mount Angel	55	25	40.6	4.78	
Nehalem				12.75	
Newberg	55	23	40.4	4.53	0.1
Newport	61	28	47.0	6.90	
Pendleton	61	23	38.7	1.98	2.0
Placer				3.83	
Riddles [*1]	64	28	45.0	3.38	
Riverside	52	8	30.8	1.24	T.
Salem *b*	56	25	40.4	5.32	
Sheridan [*1]	57	26	44.4	5.35	T.
Silverlake	56	− 4	31.3		
Silverton [*1]	56	26	42.5	5.18	
Siskiyou [*1]	57	25	38.6	4.47	11.5
Smock	53	19	37.1	3.92	1.7
Sparta	48	3	29.2	3.50	13.0
Springfield [*1]	60	25	40.4	5.24	
Stafford	54	24	39.4	4.54	T.
The Dalles	60	32	38.7	3.04	
Toledo	65	24	45.2	8.65	
Umatilla				1.11	
Vale	55	9	32.9	1.62	
Westfork [*1]	60	28	41.3	2.68	
Weston	67	16	35.2	3.03	7.0
Williams	78	17	39.5	5.51	2.0
Pennsylvania.					
Aleppo	70	−11	30.6	4.79	4.0
Altoona	64	− 4	27.0	4.92	
Athens	64	− 5	26.8	4.47	11.7
Beaver Dam				2.62	
Bellefonte	67	− 2	29.6	6.06	12.0
Bethlehem				6.83	
Brookville				3.32	5.2
Browers Lock				7.68	
California	71	− 7	33.2	4.24	3.8
Cassandra	60	− 5	28.4	3.73	13.0
Clarion				4.00	9.2
Coatesville	65	6	32.8	9.24	1.3
Confluence				4.65	1.0
Davis Island Dam				5.13	
Derry Station	65	− 3	30.6	5.12	4.8
Driftwood				5.30	5.0
Duncannon				5.97	4.0
Dushore	63	−11	25.1	7.13	13.7
Dyberry	61	−15	24.4	6.66	21.1
East Bloomsburg				6.10	13.5
East Mauch Chunk	62	− 2	28.8	10.26	6.0
Easton	62	4	30.2	6.90	1.5
Ellwood Junction				3.79	3.0
Emporium	64	− 6	27.0	5.22	11.1
Ephrata	65	5	30.6	5.67	1.8
Everett	64[b]	− 3[b]	27.2[b]	5.54	3.8
Forks of Neshaminy [*1]	63	5	30.0	7.94	2.0
Franklin	66	− 9	28.8	3.51	4.0
Freeport				4.38	4.3
Girardville				7.87	13.5
Greensboro				5.64	4.0
Hamburg				7.19	4.0
Hamlinton	61	− 4	22.9	6.34	19.0
Hawthorn	63	−18	27.8	4.40	5.8
Herrs Island Dam				4.54	4.0
Huntingdon *a*	66	0	29.6	6.73	5.5
Huntingdon *b*				5.61	5.8
Irwin				3.60	
Johnstown	64	− 2	30.8	5.16	0.5
Karthaus				3.30	8.0
Kennett Square	64	6	32.6	8.66	1.0
Lancaster	65	5	28.6		
Lawrenceville	68	− 5	26.2	6.22	
Lebanon	65	3	31.0	6.35	3.2
Leroy	62	− 2	25.4	8.26	22.8
Lewisburg	68	− 8	27.3	6.90	9.5
Lockhaven *a*	66	− 2	29.4	5.70	13.0
Lockhaven *b*				5.72	
Lock No. 4				5.22	4.5
Lycippus	77	− 4	30.0	4.79	7.8
Mifflin				3.40	5.0
Oil City				4.31	3.7
Parker				4.86	3.0
Philadelphia	66	15	35.6	7.07	0.5
Pocono Lake	59	−14	24.8	7.04	10.0
Pottstown	63	10	34.0	8.15	1.5
Quakertown	64	1	31.2	8.08	2.8
Reading [2]			30.2	5.97	
Renovo *a*				4.86	8.0
Pennsylvania—Cont'd.					
Renovo *b*	65	− 1	27.6	4.99	11.4
Saegerstown	64	−10	28.4	3.33	7.0
St. Marys	58[c]	− 7[d]	24.2[d]	4.26	15.0
Saltsburg				4.40	3.0
Selinsgrove	67	− 4	29.3	4.84	9.0
Shawmont				6.87	
Smethport	61	− 7	26.2	4.45	16.0
Somerset	45	−12	24.8	5.49	12.2
South Eaton	64	− 6	28.0	6.16	14.0
State College	60	− 2	27.0	6.59	9.2
Sunbury				5.40	10.0
Swarthmore	67	7	31.1	6.97	1.0
Towanda	65	−12	26.8	6.00	14.5
Troutrun				6.93	21.8
Uniontown	64	2	31.6	7.12	4.5
Warren	57	− 6	26.0	3.10	6.0
Wellsboro	63	−10	27.0	5.66	17.0
Westchester	63	8	32.6	8.59	1.2
West Newton				5.23	5.0
Westtown [1]	64	5	32.8	6.25	
Wilkesbarre	67	− 2	29.5	5.98	12.0
Williamsport	65	1	27.0	5.86	11.0
York	64	4	31.2	6.17	2.9
Rhode Island.					
Bristol	58	8	32.6	9.16	5.0
Kingston	58	0	30.6	10.30	6.5
Pawtucket	59	3	32.2	8.42	3.0
Providence *a*	59	7	32.6	9.40	5.5
Providence *c*	60	6	31.6	9.18	5.0
South Carolina.					
Aiken	76	10	45.6	5.75	2.0
Anderson	69	12	42.7	8.80	T.
Barksdale	66	11	42.8	7.27	0.3
Batesburg	71	18	45.3	6.83	0.9
Beaufort	74	20	49.4	1.59	T.
Blackville	80	14	47.0	4.17	T.
Bowman	76	14	46.9	2.23	T.
Calhoun Falls				7.16	1.6
Camden				5.37	0.3
Cheraw *a*	74	12	42.0	4.66	
Cheraw *b*				4.71	T.
Clemson College	68	9	39.0	9.50	0.4
Conway	78	14	46.2	5.21	T.
Darlington	76	13	43.4	5.01	0.4
Edisto				4.21	0.6
Effingham				4.05	0.2
Florence	74	17	43.2	3.67	
Gaffney	68	11	39.4	9.62	1.7
Georgetown	75	19	47.2	4.85	T.
Gillisonville	75	13	47.2	1.28	T.
Greenville	66	6	36.9	9.22	3.5
Greenwood	71	13	41.0	7.65	1.0
Kingstree *b*				2.91	0.4
Liberty	68	2	40.0	9.54	5.0
Little Mountain	71	15	43.8	5.13	1.5
Longshore	71	11	42.2	5.95	1.5
Lugoff	73	12	43.5	5.68	0.2
Pinopolis [*1]	74	20	47.0	2.15	T.
St. Stephens				2.39	0.1
Santuck	72	10	40.8	6.49	1.5
Smiths Mills				4.40	T.
Society Hill	73	14	43.0	5.12	T.
Spartanburg	67	7	38.6	10.23	2.5
Statesburg	74	16	46.4	5.31	2.0
Summerville	75	16	47.6	2.36	0.3
Sumter	79	10	46.4	5.06	1.4
Temperance	75	14	44.6	4.37	0.6
Trenton	72	14	47.2	5.67	2.3
Trial	76	11	46.2	2.43	T.
Walhalla	68	5	37.9	7.41	1.6
Winthrop College	70	11	41.8	6.14	0.7
Yorkville	69	12	42.6	6.71	0.9
South Dakota.					
Academy	55	−22	21.9	1.00	9.4
Alexandria	49	−26	18.4	1.45	12.5
Armour	50	−26	22.0	1.35	13.5
Ashcroft	50	−29	23.0	0.60	6.0
Bad Nation	68	−22	24.1	0.41	7.5
Bowdle	50	−29	13.2	0.35	3.5
Brookings	46	−26	15.2	0.15	1.9
Canton	46	−34	17.4	0.09	6.0
Centerville				0.80	7.
Chamberlain	52	−20	20.7	0.51	4.
Clark	42	−32	12.8	0.64	6.
Desmet	43	−26	15.0	1.25	11.4
Doland	47	−26	16.4	0.56	3.0
Elkpoint	49	−31	19.4	1.24	12.8
Farmingdale				0.44	3.8
Faulkton	40	−23	17.2	0.25	3.5
Flandreau	44	−29	15.5	0.30	3.5
Forestburg	45	−27	16.4	0.50	5.0
Fort Meade	55[e]	−22	31.3[e]	0.89	6.0
Gannvalley	50	−23	18.6	0.65	6.3
Gary	44	−26	14.2	0.15	3.5
Grand River School	57	−28	17.8	0.53	10.0
Greenwood	57	−26	22.8	1.13	11.5

TABLE II.—*Climatological record of voluntary and other cooperating observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
South Dakota—Cont'd.	°	°	°	*Ins.*	*Ins.*
Hartman	45	−30	16.2	0.25	2.5
Hotch City	63	−25	21.7	0.29	5.0
Howard	43	.....	.....	0.61	6.1
Interior	54°	−30°	24.4°	0.56	4.6
Ipswich	40	−25	15.8	0.13	6.5
Kimball	50	−20	19.3	0.93	8.2
Leola	40	−31	10.9	0.41	7.0
Leslie	59	−28	19.2	0.40	.....
Marion	48	−28	18.6	0.24	5.0
Mellette	47	−23	17.4	0.29	2.0
Menno	49	−27	18.2	0.76	7.9
Millbank	55	−26	17.6	0.55	5.5
Mitchell	49*	−24	21.8*	0.30	3.0
Mound City	44	−30	15.3	0.35	5.0
Oelrichs	60	−42	24.4	1.20	7.0
Pine Ridge	55	−41	24.4	0.27	5.0
Plankinton	45	−25	17.8	0.47	5.0
Redfield	43	−26	16.2	0.43	3.5
Rochford	58	−35	22.1	2.13	17.0
Rosebud	56	−24	23.9	0.33	3.8
St. Lawrence	56	−28	18.8	0.22	0.7
Silver City	.....	.....	.....	1.20	6.0
Sioux Falls	48	−28	16.6	0.65	6.5
Sisseton Agency	43	−29	14.8	0.43	4.3
Spearfish	54	−17	27.5	0.79	6.5
Vermillion	48	−26	19.4	0.94	10.0
Waubay	43	−31	13.8	0.14	4.0
Wentworth	47	−27	15.9	0.28	3.3
Wessington Springs	57	−27	18.4	.....	.....
Wolsey	.....	.....	.....	0.85	6.5
Tennessee.					
Andersonville	62	− 6	35.2	6.88	4.0
Ashwood	65	− 3	36.0	3.87	1.5
Benton	69	2	38.4	10.61	3.5
Bluff City	.....	.....	.....	8.00	6.0
Bolivar	66°	− 2°	34 8°	4.83	6.6
Bristol	67	− 8	32.2	8.07	T.
Byrdstown	67	− 9	34.4	5.85	11.3
Carthage	67	− 4	35.0	5.07	6.7
Charleston	.....	.....	.....	9.69	.....
Clarksville	66	− 5	34.2	5.63	7.5
Clinton	.....	.....	.....	10.58	3.1
Decatur	69	1	36 5	12.63	10.8
Dickson	65	− 8	35.2	3.35	3.2
Dover	66	− 9	35.4	.....	....
Elizabethton	70°	−12	33.1	6.74	.....
Erasmus	63	−15	33.4	8.61	6.8
Florence	66	− 3	35.2	4.68	4.0
Franklin	66	− 2	35.0	5.07	2.5
Grace	.....	.....	.....	7.10	6.0
Greeneville	68	− 8	34 8	9.51	5.0
Harriman	65	0	34.4	10.55	5.8
Hohenwald	65	− 6	34.2	7.00	4.2
Iron City	67	− 5	36.7	5.70	2.0
Johnsonville	69	− 8	34.6	5.17	3.4
Jonesboro *1	66	−10	33.8	9.05	5.8
Kingston	.....	.....	.....	11.39	5.5
Lafayette	62	− 5	33.4	5.95	6.5
Lewisburg	66	− 3	36.4	5.54	2.4
Liberty	70	− 6[d]	34.8	5.21	3.5
Lynnville	62	− 2	35.0	4 31	2.0
McKenzie	68	− 5	33.6	2.26	.....
Maryville	70	− 2	36.2	12.23	6.5
Newport	70	− 5	35.0	9.78	3.5
Nunnelly	68°	− 5	36 2	4.60	1.0
Palmetto	66	− 3	36.4	5.14	3.5
Peryear *b	60	− 6	34.1	3.10	T.
Pope	68	− 6	36.3	6.33	4.5
Rogersville	65	− 5	34.0	10.70	7.7
Rugby	64	−18	32.8	9.03	12 0
Savannah	66	0	37.8	5.64	.....
Sewanee	.....	− 5	.....	10.13	4.0
Silverlake	61	− 9[d]	34.0	8.36	4.2
Springdale	71	−11	34.4	10.72	9.9
Tellico Plains	70	− 2	39.0	11.05	9.5
Tracy City	62	− 4	33.6	9.50	5.5
Trenton	69	− 4	35.9	4.74	4.6
Tullahoma	65	− 4	34.6	7.00	3.0
Union City	65	− 8[h]	36.2[f]	4.10	13.0
Waynesboro	68	− 6	34.6	6.06	4.5
Wildersville	66[b]	− 3[d]	36.5[c]	5.38	4.3
Yukon	67[c]	− 3[c]	36.2[c]	6.35	.....
Texas.					
Albany	78	11	43.0	0.28	2.0
Alvin	.....	.....	.....	3.94	.....
Arthur	.....	.....	.....	1.13	0.2
Austin *a*	76[f]	17[c]	48.2[f]	0.06	.....
Austin *b* *3	76	12	46.7	.....	.....
Ballinger	80	9	44.8	0.22	.....
Bastrop	81	9	48.6	0.46	.....
Beaumont	74	22	50.4	7.29	.....
Beeville	87	14	53.2	0.77	.....
Big Spring	.....	.....	.....	0.24	T.
Boerne *1	80	10	48.7	0.33	T.
Booth	.....	.....	.....	3.16	.....
Bowie	76	7	46.3	0.61	T.

Stations	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Texas—Cont'd.	°	°	°	*Ins.*	*Ins.*
Brazoria	80	23	52.4	2.95	
Brenham	80	16	51.4	1.51	
Brighton	81[j]	24	58 0*	0.46	
Burnet	92	8	48.4	0.33	
Camp Eagle Pass	85	16	49.1	0.00	
Coleman	82	10	47.1	0.26	
College Station	.....	14	.....	0.35	
Columbia	79	20	51.6	3.10	
Comanche	79	8	48.2	0.57	T.
Corsicana	78	8	45.2	1.06	
Cotulla	82	21	54.1	T.	
Cuero	80	18	52.5	2.55	
Dallas	82	9	42.7	0.58	T.
Danevang	83	18	52.8	4.23	
Dublin	76	14	43.8	0.90	
Duval	77	18	50.6	0.80	
Estelle	84	9	46.3	0.56	T.
Fort Brown	.....	.....	.....	0.00	
Fort Clark	83	15	51.4	0.00	
Fort McIntosh	87	23	56.8	0.00	
Fort Ringgold	84	26	60.6	0.00	
Fort Stockton	.....	.....	.....	0.00	
Fredericksburg	82°	11°	47.8°	0.67	
Gainesville	81°	8[d]	41.2°	1.23	
Georgetown *1	77[h]	13[h]	47.8°	0.73	
Grapevine	84°	9°	47.0°	0.94	0.4
Hale Center	73	10	41.2	0.35	3.5
Hallettsville	81	19	53.5	1.79	
Haskell	79	6	42.6	0.60	2.2
Henrietta	77	2	42.8	0.72	1.5
Hewitt	.....	.....	.....	1.23	T.
Hondo	.....	.....	.....	0.17	
Houston	80	21	51.9	3.23	T.
Huntsville	77°	8°	49.2°	2.55	
Ira	76	8	42.6	0.18	1.8
Jacksonville	75[j]	14[j]	44.0[j]	.....	
Jasper	85	21	55.4	4.04	
Kaufman	78	16	45.9	.....	
Kent	.....	.....	.....	0.16	1.5
Kopperl	.....	.....	.....	0.00	
Lampasas	87	11	47.6	0.30	
Lapara	.....	.....	.....	0.48	
Longview	75	13	45.6	2.79	
Luling	80	14	51.1	0.71	
Mann	79	12	47.2	1.70	
Menardville	83	5	44.8	0.00	
Mount Blanco	76	− 2	40.2	0.60	6.0
Nacogdoches	76	15	46.0	2.19	T.
New Braunfels	79	14	51.4	0.81	
Panter	.....	.....	.....	0.23	T.
Port Lavaca	80	22	55.2	2.35	
Rhineland	80	5	43.1	0.44	5.0
Rockisland	80	17	52.8	1.73	
Rockport	75	28	58.6	.....	
Runge	83	22[c]	53.6[d]	2.83	
Sanderson	75	15	45.8	0.00	
San Marcos	79	14	50.8	0.40	
San Saba	86	7	48.6	0.24	
Santa Gertrudes Ranch	.....	.....	.....	0.18	
Sherman	72	9	42.8	0.32	T.
Sugarland	82	19	53.5	2.22	
Sulphur Springs	77	9	44.2	1.68	0.5
Temple *a*	76	11	45.2	1.89	
Temple *b*	76	12	46.1	2.08	
Trinity	80	15	49.5	2.23	
Tulia	70	1	37.6	0.20	2.0
Tyler	75	12	43.2	1.82	
Victoria	.....	.....	.....	1.50	
Waco	78	13	45.9	1.50	
Waxahachie	80	9	44.5	0.45	T.
Weatherford	80	9	44.7	0.86	T.
Wichita Falls	.....	.....	.....	0.91	2.5
Utah.					
Alpine	.....	.....	.....	1.69	.....
Aneth	67	5	33 8	0.01	
Blackrock	61	−11	23.2	0.70	8.0
Castledale	59	− 2	26.8	T.	T.
Cisco	64	0	28.4	0.15	1.5
Corinne	54	3	30.8	1.15	0.5
Coyoto	65[j]	−10[d]	28.6[d]	0.19	1.0
Deseret	61	− 8	24.3	0.76	7.0
Emery	57	3	31.4	0.00	
Escalante	59	9	32.0	T.	
Farmington	55	10	33.8	2.19	9.5
Fillmore	65	− 6	31.7	1.97	.....
Fort Duchesne	52	−10	18.0	0.51	4.0
Frisco	60	1	33.4	0.75	7.5
Giles	64	− 1	30.6	T.	
Government Creek	53	− 1	29.4	1.72	17.2
Green River	.....	− 1	.....	0.00	
Grover	60	4	33.6	0.25	2.5
Heber	54	− 6	25.8	1.50	5.0
Henefer	56	− 7	27.5	1.68	10.0
Huntsville	.....	.....	.....	1.78	10.0
Kelton *1	61	8	31.7	T.	T.
Lasal	58	− 7	28.4	0.43	4.2

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Utah—Cont'd.	°	°	°	*Ins.*	*Ins.*
Levan	56	− 6	26.4	1.40	13.5
Loa [d]	60	−18	25.3	0.40	4.0
Logan	54	3	28.6	1.32	.....
Lund	62	− 1	29.2	0.05	0.5
Manti	57	− 7	29.2	0.55	3.0
Marysvale	65	− 3	31.4	0.25	2.4
Meadowville	58	0	26.7	1.85	10.5
Millville	.....	.....	.....	1.17	.....
Minersville	61	− 1	30.4	0.72	7.2
Moab	68	6	33.2	0.28	2.3
Mount Pleasant	58	− 5	28.8	1.14	9.0
Ogden *1	50	12	32.8	0.83	1.5
Park City	51	− 5	27.0	2 20	19.0
Parowan	61	− 2	30.4	0.96	10 8
Pinto	57	− 6	29.2	0.57	6.5
Promontory	.....	.....	.....	0.99	3.5
Provo	58	0	30.2	0.98	4.7
Richfield	55[m]	− 9[f]	25.1[j]	0.74	7.2
St. George	71	6	35 7	0.00	
Scipio	61	−17	27.9	0.76	6.0
Snowville	49	4[c]	27.9[d]	1.00	T.
Soldier Summit	45	−15	20.1	0.90	9.0
Terrace	.....	.....	.....	T.	
Thistle	60	− 4	29.7	2.00	10.0
Tooele	60	9	32.1	1.83	.....
Vernal	53	− 6	26.0	0.48	3.8
Wellington	56°	− 2[j]	27.8°	0.05	0.5
Woodruff	48	−16	21.7	1.23	7.0
Vermont.					
Bennington	65°	−16°	26.2°	3.85	18.5
Burlington	63	− 1	26.1	3.69	15.0
Chelsea	56	− 5	21.6	4.64	29.0
Enosburg Falls	63	−17	23.2	5.25	29.5
Hartland	59	−20	22.0	6.43	31.0
Jacksonville	50	−18	19.0	3.95	33.0
Manchester	64	−14	24.2	4.05	22.8
Norwich	57	−17	22.9	5.32	28.0
St. Johnsbury	61	−20	21.9	4.06	25.8
Vernon *6	55	−15	23.6	7.61	29.0
Wells	60	− 5	23.4	4.28	22.5
Woodstock	64	−24	23.0	5.34	35.5
Virginia.					
Alexandria	67	7	34.3	7.53	0.5
Ashland	75	4	37.2	5.40	0.5
Barboursville	69	4	38.8	8.51	2.8
Bedford	68	7	36.2	8.10	5.5
Bigstone Gap	69	− 5	33.6	9.89	12.5
Birdsnest [2]	.....	.....	35.0	2.85	1.5
Blacksburg	64	0	30.4	7.48	6.0
Bon Air	69	7	38.0	6.94	2.0
Buckingham	69	.....	.....	7.43	1.0
Burkes Garden	60	−14	30.6	8.09	7.0
Callaville	68	4	39.4	3.86	
Charlottesville	70	7	35.3	8.35	4.2
Clifton Forge	.....	.....	.....	6.34	3.0
Dale Enterprise	66	− 2	32.8	6.36	4.0
Fredericksburg	66	5	33.6	7.90	1.0
Grahams Forge	66[b]	0[b]	31.0[b]	7.10	3.4
Hampton	67	15	41.6	3.40	T.
Hot Springs	63	− 3	28.3	9.50	0.2
Lexington	69	5	33.5	8.12	6.3
Lincoln	65	2	32.3	6.23	T.
Petersburg	70	7	38.8	6.15	1.0
Quantico	64	7	36.0	.....	.....
Radford	.....	.....	.....	6.58	3.0
Riverton	.....	.....	.....	6.66	.....
Roanoke	65	5	33.2	8.17	4.6
Speers Ferry	.....	.....	.....	11.15	10.0
Spottsville	73	7	39.7	5.82	2.5
Stanardsville	68	− 3	29.0	4.90	4.0
Staunton	70	1	35.4	6.44	3.0
Stephens City	68	1	33.1[f]	5.32	1.0
Westpoint	65	6	36.0	4.20	
Williamsburg	69	8	39.3	5.02	T.
Woodstock	70	1	34.7	3.84	2.0
Wytheville	65	0	33.1	7.65	3.3
Washington.					
Aberdeen	55	20	39.8	11.41	
Anacortes	.....	.....	.....	2.79	
Ashford	.....	.....	.....	8.23	0.5
Bremerton	63	27	42.0	3.79	
Brinnon	51	28	40.4	6.20	
Buchanan's Farm	.....	.....	.....	0.59	1.0
Cedonia	42	9	27.4	0.95	2.0
Cheney	.....	.....	.....	1.11	4.0
Clearwater	54	30	41.8	16.03	
Cle Elum	47	9	32.6	5.27	5.5
Colfax	51	11	34.4	2.35	2.0
Colville	45	9	29.6	0.99	1.7
Conconully	44	10	27.6	0.96	1.2
Connell	.....	.....	.....	0.80	
Coupeville	55	25	41.0	2.53	
Crescent	46	10	29.2	0.66	2.0
East Sound	66	24	41.5	3.19	
Ellensburg	49	12	31.7	0.89	T.
Grandmound	52	22	40.0	5.64	

TABLE II.—*Climatological record of voluntary and other cooperating observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Washington—Cont'd.	°	°	°	*Ins.*	*Ins.*
Granite Falls	.....	.....	.....	6.92	0.8
Hooper	56	16	35.0	0.75	
Ilwaco	60	27	44.3	11.49	
Lacenter	59	23	39.4	5.55	T.
Lakeside	48	15	32.8	1.84	1.5
Lind	52[f]	10[f]	31.8[f]	0.36	1.0
Mayfield [d]	56	26	39.2	6.66	
Mottinger Ranch	57	20	38.6	1.50	
Mount Pleasant	53	25	38.0	6.17	
Moxee Valley	53	13	33.0	0.82	T.
Northport	51	2	29.2	1.09	9.3
Olga	52	27	40.9	2.42	
Olympia	53	25	41.4	6.01	
Pasco	55	15	36.0	1.07	
Pinehill	53	20	38.6	4.10	T.
Pomeroy	59	20	36.5	1.79	9.0
Port Townsend	54	32	42.8	1.92	
Ritzville	.....	.....	.....	0.23	0.5
Rosalia	47	13	32.2	1.69	2.0
Sedro	55	18	38.4	4.16	
Silvana	56	20	40.4	3.65	
Snohomish	55	27	40.0	4.29	
Snoqualmie	55	23	40.7	4.38	
Southbend	57	26	42.8	11.43	
Sprague	.....	.....	.....	1.20	2.0
Sunnyside	57	13	33.8	0.73	
Twin	53[e]	28[d]	41.0[d]	8.68	
Union	54	24	41.0	8.77	
Vancouver	56	24	40.6	3.68	0.2
Vashon	53	28	41.5	4.00	
Waterville	44	8	27.2	1.13	2.5
Wenatchee (near)	52	11	28.6	1.92	0.8
Whatcom	58	21	41.8	1.97	
Wilbur	44	5	28.5	0.68	1.5
West Virginia.					
Beckley	64[c]	0[b]	32.2[c]	4.63	6.5
Beverly	65	— 3	31.6	5.82	6.0
Bluefield	65	— 2	32.7	7.77	8.5
Buckhannon	67	— 5	30.3	7.74	3.0
Byrne	70	— 7	34.3	7.60	7.0
Central	70	— 9	31.0	4.67	4.5
Charleston	.....	.....	.....	7.41	2.4
Creston	.....	.....	.....	4.39	1.0
Cuba	72	— 8	32.8	3.64	0.3
Dayton	71	— 7	31.2	5.38	3.0
Elkhorn	68	1	36.2	8.97	5.3
Fairmont	.....	.....	.....	6.02	2.5
Foster	72	0	35.0	3.95	0.8
Glenville	70	— 2	33.1	6.54	5.0
Grafton	68	— 5	32.9	4.44	5.5
Green Sulphur	60	8	31.4	6.42	2.0
Harpers Ferry	.....	.....	.....	6.96	2.0
Hinton *a*	.....	.....	.....	7.85	2.8
Hinton *b*	66	3	33.4	.....	.....
Huntington	71	— 3	31.8	5.18	3.0
Josiah	71	— 3	31.2	5.61	2.0
Leonard	60	— 4	30.8	8.85	4.2
Lewisburg	64	— 1	30.8	6.80	2.2
Logan	71	2	35.4	7.50	4.5
Magnolia	67	— 1	29.4	4.07	2.0
Mannington	71	— 4	33.6	3.69	3.0
Martinsburg	66	2	29.8	5.25	T
Morgantown	60	— 2	32.6	5.57	2.0
Moscow	67	— 5	30.4	4.03	4.0
Moundsville	70	— 5	31.2	2.07	.....
New Martinsville	74	— 2	33.2	4.28	2 5
Nuttallburg	62	1	32.2	7.05	6.0
Oceana	67	1	33.6	7.65	.....
Oldfields	71	2	34.6	4.97	T.
Parsons	70	— 4	31.2	7.50	.....
Point Pleasant	70	— 2	33.2	4.38	4.0
Powellton	70	4	34.4	5.45	3.8
Romney	72	1	31.4	5.65	1.0
Rowlesburg	.....	.....	.....	7.10	16.0
Spencer	70	— 4	32.8	6.09	4.8
Terra Alta	62	—11[d]	29.1	5.40	2.2
Uppertract	68	0	32.6	5.30	3.0
Wellsburg	66	— 5	29.6	4.63	4.5
Weston *a*	.....	.....	.....	6.54	2.0
Weston *b*	70	— 2	33.5	.....	.....
Wheeling *a*	.....	.....	.....	4.77	5.1
Wheeling *b*	69	1	35.2	4.55	3.5
Williamson	72	5	38.2	8.22	4.0
Wisconsin.					
Amherst	40	—25	15.7	0.53	5.3
Antigo	38	—28	15.4	0.25	2.5
Appleton	38	—20	18.4	0.78	5.0
Ashland	.....	.....	.....	0.64	.....
Barron	42	—40	11.2	0.40	4.0
Beloit	49	—13	22.8	1.59	.....
Brodhead	50	—14	21.8	1.16	T.
Butternut	36	—33	11.6	0.72	11.0
Chilton	36	—20	16.6	0.89	.....
Darlington	40	—16	19.1	1.46	.....
Delavan	51	—15	19.4	1.60	3.4
Dodgeville	46	—20	20.4	1.27	3.0

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Wisconsin—Cont'd.	°	°	°	*Ins.*	*Ins.*
Easton	39	—25	14.9	0.49	5.4
Eau Claire	39	—28	14.0	0.55	5.5
Florence	39	—21	15.9	1.19	10.0
Fond du Lac	44	—18	21.0	0.78	2.0
Grand River Locks	.....	.....	.....	1.29	7.9
Grantsburg	52	—39	13.8	1.02	10.2
Harvey	49	—18	21.4	1.21	3.8
Hayward	43	—38	13.6	0.53	5.3
Hillsboro	42	—27	17.4	0.75	7.5
Koepenick	42	—30	17.0	0.80	8.0
Ladysmith	40	—34	14.1	1.20	12.0
Lancaster	42	—21	18.4	1.15	4.0
Madison	44	—17	19.6	1.02	.....
Manitowoc	45	—18	21.6	1.73	4.8
Meadow Valley	40	—28	16.4	0.40	5.2
Medford	42	—28	16.8	0.50	5.0
Menasha	.....	.....	.....	0.72	4.0
Neillsville	40	—36	15.2	0.40	4.0
New Holstein	45	—19	17.0	1.35	3.0
New London	39	—24	17.7	0.97	4.5
North Crandon	36	—28	14.7	0.77	7.2
Oconto	40	—17	20.3	0.55	6.0
Osceola	41	—39	10.8	2.28	7.3
Oshkosh	41	—20	20.5	0.40	4.0
Pepin	44	—33	16.0	0.74	9.0
Pine River	39[c]	—25[c]	16.8[c]	0.67	3.4
Portage	46	—20	20.2	0.95	3.0
Port Washington	56	—21	21.4	1.80	1.5
Prairie du Chien *a*	50	—19	21.4	0.38	0.8
Prairie du Chien *b*	.....	.....	.....	0.26	1.5
Prentice	37	—32	14.2	1.20	12.0
Racine	57	—14	23.2	1.29	.....
Sheboygan	48	—16	23.2	1.32	5.8
Stevens Point	42[c]	—28[c]	16.2[c]	0.50	5.0
Viroqua	40	—26	16.8	0.51	3.2
Watertown	48	—18	20.2	1.49	6.0
Waukesha	49	—16	20.3	1.49	3.7
Waupaca	39	—24	17.4	0.59	3.5
Wausau	38	—27	17.2	1.66	.....
Westbend	51[c]	—15[c]	20.8[c]	.....	.....
Westfield	38	—22	18.6	0.72	4.0
Whitehall	41	—30	16.5	0.87	9.0
Wyoming.					
Alcova	52	—22	26.8	1.37	18.0
Basin	45[c]	—11[c]	18.4[c]	0.85	8.5
Bedford	46	—11	22.2	2.15	12.0
Bigpiney	44	—26	16.3	0.70	7.0
Buffalo	50[j]	—24	25.4[c]	1.09	12.7
Chugwater	58	—34	28.8	1.71	16.0
Daniel	46	—17	18.3	1.30	13.0
Embar	55	—19	26.2	1.10	11.0
Evanston	47	—14	23.2	1.81	12.5
Fort Washakie	57	—24	23.0	1.26	12.4
Fort Yellowstone	41	— 3	22.1	2.53	24.0
Fourbear	57	—23	25.8	0.25	5.4
Griggs	60	—33	27.4	0.90	6.9
Hyattville	58	—21	24.2	1.20	12.0
Iron Mountain	53	—20	25.2	0.90	8.5
Laramie	50	—23	21.2	0.21	.....
Lusk	52	—32	23.4	1.10	11.0
Parkman	60	—25	27.7	1.02	13.4
Pinebluff	69[d]	—28	27.6	1.60	16.0
Rawlins	54	— 2	23.8	1.86	18.6
Rocksprings	54	— 6	26.8	0.46	1.2
Saratoga	47	—21	24.4	1.95	14.5
Sheridan	51	—34	25.6	1.46	11.0
South Pass City	36[b]	—21[c]	13.6[c]	1.50	15.0
Thayne	44	—15	21.4	1.57	8.1
Thermopolis	53	—22	22.4	1.53	14.0
Cuba.					
Aguacate	96	43	68.4	0.44	
Alvarez	.....	.....	.....	1.60	
Australia	87	49	69.2	2.78	
Banaguises	81	57	69.8	2.18	
Batabano	81	47	67.5	0.18	
Calimete	86	54	72.2	3.58	
Camajuani	85	51	65.8	2.45	
Ciego de Avila	.....	.....	.....	1.92	
Cruces	.....	.....	.....	1.04	
Gibara	91	61	74.2	6.39	
Guabairo	.....	.....	.....	1.58	
Guanajay	82	49	67.8	0.80	
Guantanamo	89	62	75.5	0.57	
Guines	94	62	80.0	0.91	
Holguin	91	63	74.4	5.20	
Isabel, Guantanamo	.....	.....	.....	0.28	
Los Canos	91	58	75.2	1.12	
Luisa, Guantanamo	.....	.....	.....	0.32	
Magdalena	86[b]	49[b]	69.6[c]	1.42	
Manzanillo	89	66	77.4	0.81	
Moron Trocha	92	57	76.2	1.64	
Pinar del Rio	83	47	69.2	1.83	
Romelle, Guantanamo	.....	.....	.....	0.15	
San Cayetano	89	44	68.0	0.50	
Sancti Spiritus	84	55	69.4	1.28	
San Emelio, Guanta'mo	.....	.....	.....	0.32	

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Cuba—Cont'd.	°	°	°	*Ins.*	*Ins.*
Santa Clara	89	53	70.6	1.99	
San Vicente	.....	.....	.....	0.41	
Soledad	86	50	70.0	1.66	
Soledad, Guantanamo [d]	92	59	75.2	0.06	
Union de Reyes	87	57	71.7	1.36	
Yaguajay	89	54	70.7	3.20	
Yateras	.....	.....	.....	0.32	
Porto Rico.					
Adjuntas	85[d]	54	69.4	4.60	
Aguadilla [g]	86	65	75.8	4.80	
Aguirre	89	66	77.0	3.44	
Arecibo	85	62	74.3	8.15	
Barros	93	56	72.8	6.40	
Bayamon	93	64	77.2	9.97	
Caguas	86	60	73.3	5.73	
Canovanas	84	67	76.2	5.77	
Cayey	92	58	75.0	4.09	
Coamo [g]	92	61	77.4	14.50	
Corozal	86	58	72.4	10.36	
Fajardo	88	69	78.4	6.71	
Guayamo	.....	.....	.....	4.24	
Hacienda Amistad	90	56	73 6	3.10	
Hacienda Coloso	97	59	75.4	5.23	
Hacienda Perla	84	69	75.8	13.03	
Humacao	85	60	71.8	6.40	
Isabela	88	66	77.2	9.36	
Juan Diaz	91	63	77.4	1.83	
La Isolina	86	62	73.4	10.67	
Las Marias	94	65	77.6	2.59	
Manati	91	63	75.4	7.00	
Maunabo	87	69	78.0	11.04	
Mayaguez	85	62	74.4	2.08	
Ponce	88	64	76.1	2.32	
Rio Piedras	.....	.....	.....	7.82	
San German	.....	.....	.....	4.90	
San Salvador	85	61	72.4	4.34	
Santa Isabel	89	64	76.3	1.17	
Utuado	88	61	74.7	3.75	
Yauco	84	56	74.0	1.52	
Mexico.					
Ciudad P. Diaz	79	20	52.1	T.	
Coatzacoalcos	86	46	67.4	13.77	
Leon de Aldamas	74	28	54.7	T.	
Vera Cruz	80	54	70.2	0.00	
New Brunswick.					
St. John	50	— 1	26.9	7.67	17.4
Isthmus of Panama.					
Alhajuela	90	66	75.4	4.88	
La Boca	86	74	79.2	.....	

Late reports for November, 1901.

Stations.	Maximum.	Minimum.	Mean.	Rain and melted snow.	Total depth of snow.
Alaska.	°	°	°	*Ins.*	*Ins.*
Coal Harbor	48	16	33.0	3.25	7.0
Kenai	42	— 4	19.9	0.64	8.6
Orca	47	21	33.5	8.02	30.0
California.					
Bakersfield	85	34	56.9	0.00	
Drytown	76	38	54.4	.....	
Hanford	94	28	52.4	0.80	
Ogilby*[1]	95	60	77.4	0.00	
Placerville	71	30	49.8	3.74	
Storey	80	35	55.2	1.67	
Ventura	84	43	60.2	0.91	
Wasco	.....	.....	.....	T.	
Colorado.					
Clearview	61	11	35.4	T.	T.
Florida.					
Carrabelle	80	32[c]	56.0	1.13	
Micanopy	83	26	56.8	0.00	
Iowa.					
Larrabee	67	8	33.4	1.25	1.5
Primghar	.....	.....	.....	0.75	
Kansas.					
Hays	78	15	42.3	0.75	
Kentucky.					
Bowling Green	72	11	39.7	1.25	
Michigan.					
Mount Clemens	60[f]	12	34.5[c]	0.89	
Minnesota.					
Lakeside	57	6	30.8	0.80	1.0
Mississippi.					
Hazlehurst	85	38	60.0	1.80	
Leakesville	86	.....	.....	1.90	
Missouri.					
Arthur	77	14	45.2	0.32	
Nebraska.					
Franklin	73	17	41.5	0.45	
New Hampshire.					
Grafton	55	2	27.8	2.20	10.5
New Mexico.					
Raton	65	21	44.2	00.0	

TABLE II.—*Climatological record of voluntary and other cooperating observers*—Continued.

Stations.	Temperature. (Fahrenheit.) Maximum.	Minimum.	Mean.	Precipitation. Rain and melted snow.	Total depth of snow.
Ohio.	°	°	°	*Ins.*	*Ins.*
Benton Ridge	.....	.....	.....	1.23	2.4
Colebrook[c]	53	12	34.0	2.47	6.6
South Dakota.					
Rochford	68	4	35.4	0.48	2.0
Texas.					
Shaeffers Ranch[f]	87	45	68.4	0.32	
Utah.					
Lasal	81	20	43.6	0.01	
Wisconsin.					
Racine	66	16	36.8	0.87	
Porto Rico.					
Vieques	90	74	82.2	3.25	

EXPLANATION OF SIGNS.

[a] Extremes of temperature from observed readings of dry thermometer.

A numeral following the name of a station indicates the hours of observation from which the mean temperature was obtained, thus:

[1] Mean of 7 a. m. + 2 p. m. + 9 p. m. + 9 p. m. ÷ 4.
[2] Mean of 8 a. m. + 8 p. m. ÷ 2.
[3] Mean of 7 a. m. + 7 p. m. ÷ 2.
[4] Mean of 6 a. m. + 6 p. m. ÷ 2.
[5] Mean of 7 a. m. + 2 p. m. ÷ 2.
[6] Mean of readings at various hours reduced to true daily mean by special tables.
[7] Mean from hourly readings of thermograph.
[8] Mean of sunrise and noon.
[10] Mean of sunrise, noon, sunset, and midnight.

The absence of a numeral indicates that the mean temperature has been obtained from daily readings of the maximum and minimum thermometers.

An italic letter following the name of a station, as "Livingston *a*," "Livingston *b*," indicates that two or more observers, as the case may be, are reporting from the same station. A small roman letter following the name of a station, or in figure columns, indicates the number of days missing from the record; for instance "[a]" denotes 14 days missing.

No note is made of breaks in the continuity of temperature records when the same do not exceed two days. All known breaks, of whatever duration, in the precipitation record receive appropriate notice.

CORRECTIONS.

November, 1901, Texas, New Braunfels, make mean temperature 61.6 instead of 60.9. Ohio, Oberlin, make precipitation 2.36 instead of 2.31.

TABLE III.—*Resultant winds from observations at 8 a. m. and 8 p. m., daily, during the month of December, 1901.*

Stations.	Component direction from—				Resultant.	
	N.	S.	E.	W.	Direction from—	Duration.
New England.	*Hours.*	*Hours.*	*Hours.*	*Hours.*	°	*Hours.*
Eastport, Me	26	13	10	24	n. 47 w.	19
Portland, Me	26	17	10	25	n. 59 w.	18
Northfield, Vt	32	24	3	8	n 32 w.	9
Boston, Mass	2	17	6	30	s. 58 w.	28
Nantucket, Mass	24	20	10	23	n 73 w.	14
Block Island, R. I	23	14	15	24	n. 45 w.	13
New Haven, Conn	32	16	7	20	n. 39 w.	21
Middle Atlantic States.						
Albany, N. Y	28	17	9	17	n. 36 w.	14
Binghamton, N. Y†	9	4	14	9	n. 45 e.	7
New York, N. Y	26	14	10	28	n. 56 w.	22
Harrisburg, Pa†	11	8	9	11	n. 34 w.	4
Philadelphia, Pa	28	19	11	20	n. 45 w	13
Scranton, Pa	29	16	7	25	n. 54 w.	22
Atlantic City, N. J	28	17	6	25	n 60 w.	22
Cape May, N. J	31	17	7	21	n. 45 w.	20
Baltimore, Md	25	14	16	23	n. 32 w.	13
Washington, D. C	29	16	10	21	n. 40 w.	17
Lynchburg, Va	20	20	12	24	w.	12
Norfolk, Va	26	22	8	13	n. 51 w.	6
Richmond, Va	30	22	10	14	n. 27 w.	9
South Atlantic States.						
Charlotte, N. C	21	25	20	14	s. 56 e.	7
Hatteras, N. C	29	17	10	17	n. 30 w.	14
Raleigh, N. C	25	21	8	19	n. 70 w.	12
Wilmington, N. C	23	18	14	19	n. 45 w.	7
Charleston, S. C	23	19	18	15	n 37 e.	5
Columbia, S. C	22	22	20	13	e.	7
Augusta, Ga	22	16	15	28	n. 65 w.	14
Savannah, Ga	20	15	18	19	n. 11 w.	5
Jacksonville, Fla	21	16	16	25	n. 61 w.	10
Florida Peninsula.						
Jupiter, Fla	18	10	20	26	n. 72 w.	6
Key West, Fla	29	6	35	6	n. 52 e.	37
Tampa, Fla	26	15	25	12	n. 50 e.	17
Eastern Gulf States.						
Atlanta, Ga	16	21	17	25	s. 58 w.	9
Macon, Ga†	14	8	7	9	n. 18 w.	6
Pensacola, Fla†	15	5	8	9	n. 6 w.	10
Mobile, Ala	27	22	12	13	n. 11 w.	5
Montgomery, Ala	12	18	19	21	s. 18 w.	6
Meridian, Miss	14	5	8	11	n. 18 w.	10
Vicksburg, Miss	25	22	20	10	n. 73 e.	10
New Orleans, La	26	19	21	12	n. 52 e.	11
Western Gulf States.						
Shreveport, La	15	21	19	20	s. 9 w.	6
Fort Smith, Ark	18	5	29	22	n. 28 e.	15
Little Rock, Ark	24	22	17	16	n. 27 e.	2
Corpus Christi, Tex	27	19	15	13	n. 14 e.	8
Fort Worth, Tex	23	22	13	23	n. 84 w.	10
Galveston, Tex	24	19	18	15	n. 31 e.	6
Palestine, Tex	24	21	16	13	n. 45 e.	4
San Antonio, Tex	25	19	21	16	n. 40 e.	8
Taylor, Tex†	14	10	2	11	n. 66 w.	10
Ohio Valley and Tennessee.						
Chattanooga, Tenn	23	19	13	20	n. 60 w.	8
Knoxville, Tenn	29	14	17	20	n. 11 w.	15
Memphis, Tenn	24	17	15	16	n. 8 w.	7
Nashville, Tenn	20	23	16	14	s. 34 e.	4
Lexington, Ky†	6	15	6	11	s. 29 w.	10
Louisville, Ky	19	25	14	16	s. 16 w.	7
Evansville, Ind†	12	10	8	8	n.	2
Indianapolis, Ind	21	22	13	18	s. 79 w.	5
Cincinnati, Ohio	18	19	18	22	s. 76 w.	4
Columbus, Ohio	15	25	16	21	s. 27 w.	11
Pittsburg, Pa	22	18	11	24	n. 73 w.	14
Parkersburg, W. Va	22	17	14	25	n. 67 w.	13
Elkins, W. Va	22	19	6	23	n. 80 w.	17
Lower Lake Region.						
Buffalo, N. Y	10	21	13	30	s. 57 w.	20
Oswego, N. Y	11	36	14	16	s. 5 w.	25
Rochester, N. Y	7	29	9	32	s. 46 w.	32
Erie, Pa	14	26	6	25	s. 58 w.	22
Cleveland, Ohio	12	33	10	23	s. 31 w.	25
Sandusky, Ohio	10	26	8	33	s. 57 w.	30
Toledo, Ohio	15	28	7	30	s. 61 w.	26
Detroit, Mich	15	22	6	30	s. 74 w.	25
Upper Lake Region.						
Alpena, Mich	14	16	2	40	n. 87 w.	38
Escanaba, Mich	13	18	5	36	s. 81 w.	31
Grand Haven, Mich	16	21	16	21	s. 45 w.	7
Houghton, Mich.†	10	6	7	14	n. 60 w.	8
Marquette, Mich	14	21	4	37	s. 78 w.	34
Port Huron, Mich	14	27	4	32	s. 65 w.	31
Sault Ste. Marie, Mich	18	21	30	10	s. 81 e.	20
Chicago, Ill	18	20	8	27	s. 84 w.	19
Milwaukee, Wis	17	16	4	36	n. 88 w.	32
Green Bay, Wis	16	23	6	29	s. 73 w.	24
Duluth, Minn	18	24	5	33	s. 78 w.	29
North Dakota.						
Moorhead, Minn	18	24	13	27	s. 67 w.	15
Bismarck, N. Dak	26	9	9	34	n. 56 w.	30
Williston, N. Dak	22	15	8	30	n. 72 w.	23

Stations.	Component direction from—				Resultant.	
	N.	S.	E.	W.	Direction from—	Duration.
Upper Mississippi Valley.	*Hours.*	*Hours.*	*Hours.*	*Hours.*	°	*Hours.*
St. Paul, Minn	21	17	8	30	n. 80 w.	22
LaCrosse, Wis†	11	14	3	11	s. 69 w.	8
Davenport, Iowa	15	18	14	30	s. 79 w.	16
Des Moines, Iowa	25	14	13	23	n. 42 w.	15
Dubuque, Iowa	28	17	12	28	n. 69 w.	17
Keokuk, Iowa	21	24	14	26	s. 76 w.	12
Cairo, Ill	23	26	12	16	s. 53 w.	5
Springfield, Ill	25	22	8	21	n. 77 w.	13
Hannibal, Mo†	10	12	5	11	s. 72 w.	6
St. Louis, Mo	17	25	11	20	s. 48 w.	12
Missouri Valley.						
Columbia, Mo*	9	10	8	8	s.	1
Kansas City, Mo	24	22	12	21	n. 77 w.	9
Springfield, Mo	22	23	16	15	s 45 e.	1
Lincoln, Nebr	30	16	5	17	n. 41 w.	18
Omaha, Nebr	28	19	10	21	n. 51 w.	14
Valentine, Nebr	24	7	9	35	n. 57 w.	31
Sioux City, Iowa†	15	10	3	11	n. 58 w.	9
Pierre, S. Dak	26	10	20	19	n. 3 e.	16
Huron, S. Dak	25	14	13	25	n. 47 w.	16
Yankton, S. Dak†	.....	.....	.....	.....	.....	.....
Northern Slope.						
Havre, Mont	11	21	9	39	s. 72 w.	32
Miles City, Mont	18	23	8	23	s. 72 w.	16
Helena, Mont	11	18	6	42	s. 79 w.	37
Kalispell, Mont	8	17	4	42	s. 77 w.	39
Rapid City, S. Dak	24	7	12	32	n. 50 w.	26
Cheyenne, Wyo	33	8	5	34	n. 49 w.	38
Lander, Wyo	15	26	17	19	s. 10 w.	11
North Platte, Nebr	17	12	9	35	n. 79 w.	26
Middle Slope.						
Denver, Colo	17	24	17	19	s. 16 w.	7
Pueblo, Colo	18	13	18	25	n. 54 w.	9
Concordia, Kans	27	21	11	17	n. 45 w.	8
Dodge, Kans	27	11	13	29	n. 45 w.	23
Wichita, Kans	33	19	6	12	n. 23 w.	15
Oklahoma, Okla	32	20	5	13	n. 34 w.	14
Southern Slope.						
Abilene, Tex	25	21	12	20	n. 63 w.	9
Amarillo, Tex	22	19	12	25	n. 77 w.	13
Southern Plateau.						
El Paso, Tex	24	4	10	39	n. 55 w.	35
Santa Fe, N. Mex	26	18	24	9	n. 62 e	17
Flagstaff, Ariz	18	10	24	23	n. 7 e.	8
Phoenix, Ariz	16	9	28	19	n. 52 e.	11
Yuma, Ariz	39	3	17	12	n. 8 e.	36
Independence, Cal	32	13	8	25	n. 42 w.	26
Middle Plateau.						
Carson City, Nev	20	21	13	19	s. 80 w.	6
Winnemucca, Nev	18	20	16	24	s. 76 w.	8
Modena, Utah	20	8	17	30	n. 47 w.	18
Salt Lake City, Utah	15	24	26	12	s. 57 e.	17
Grand Junction, Colo	19	16	22	19	n. 45 e.	4
Northern Plateau.						
Baker City, Oreg	22	25	18	19	s. 18 w.	3
Boise, Idaho	18	20	15	26	s. 80 w.	11
Lewiston, Idaho†	5	11	14	8	s. 45 e.	8
Pocatello, Idaho	6	31	20	27	s. 16 w.	26
Spokane, Wash	19	27	10	20	s. 51 w.	13
Walla Walla, Wash	2	47	10	14	s. 5 w.	45
North Pacific Coast Region.						
Neah Bay, Wash	3	30	27	19	s. 17 e.	28
Port Crescent, Wash*	0	15	12	12	s.	15
Seattle, Wash	12	30	31	2	s. 58 e.	34
Tacoma, Wash	12	34	12	19	s. 18 w.	23
Astoria, Oreg	23	16	28	12	n. 66 e.	18
Portland, Oreg	12	27	12	22	s. 34 w.	18
Roseburg, Oreg	15	14	28	14	n. 86 e.	14
Middle Pacific Coast Region.						
Eureka, Cal	23	25	18	17	s. 27 e.	2
Mount Tamalpais, Cal	37	5	17	18	n. 2 w.	32
Red Bluff, Cal	35	16	12	8	n. 12 e.	19
Sacramento, Cal	29	17	24	8	n. 53 e.	20
San Francisco, Cal	32	8	7	23	n. 32 w.	30
South Pacific Coast Region.						
Fresno, Cal	19	8	15	30	n. 54 w.	19
Los Angeles, Cal	28	7	19	26	n. 18 w.	22
San Diego, Cal	36	5	22	20	n. 4 e.	31
San Luis Obispo, Cal	50	4	3	10	n. 9 w.	46
West Indies.						
Basseterre, St. Kitts Island	22	0	52	0	n. 67 e.	57
Bridgetown, Barbados	13	1	56	0	n. 78 e.	29
Cienfuegos, Cuba	43	1	35	3	n. 37 e.	53
Grand Turk†	5	6	25	1	s. 88 e.	24
Havana, Cuba	16	7	38	7	n. 74 e.	32
Kingston, Jamaica	51	1	22	2	n. 22 e.	54
Port of Spain, Trinidad	15	14	40	4	n. 88 e.	36
Puerto Principe, Cuba	41	2	37	3	n. 41 e.	52
Roseau, Dominica, W. I	23	5	47	1	n. 69 e.	49
San Juan, Porto Rico	5	22	45	2	s. 68 e.	41
Santiago de Cuba, Cuba	45	5	12	11	n. 1 e.	40
Santo Domingo, W. I	55	4	11	1	n. 10 e.	50
Willemstad, Curaçao	7	2	57	0	n. 86 e.	58

* From observations at 8 p. m. only.

† From observations at 8 a. m. only.

TABLE IV.—*Thunderstorms and auroras, December*, 1901.

States.	No. of stations.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total. No.	Total. Days.	
Alabama	52	T.	....	3	....	..	....	...	....	....	....	....	....	....	2	7	....	...	....	....	....	....	1	....	....	....	....	....	2	3	....	....	....	18	6	T.
		A.	....	....	...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Arizona	56	T.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	....	....	....	....	....	....	....	2	1	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Arkansas	57	T.	5	....	....	....	....	....	....	8	1	...	....	6	11	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	32	6	T.
		A.	....	....	..	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
California	107	T.	..	....	....	....	1	...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1	T.
		A.	...	....	....	....	...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1	A.
Colorado	81	T.	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Connecticut	21	T.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	T.
		A.	...	....	....	....	....	.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Delaware	5	T.	....	....	....	....	....	....	....	....	....	....	....	....	....	..	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Dist. of Columbia	4	T.	....	....	....	....	....	....	....	....	....	....	....	....	....	..	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Florida	47	T.	1	4	1	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	7	4	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Georgia	55	T.	....	....	....	....	....	....	....	....	1	....	...	....	1	....	..	....	....	....	....	....	....	....	....	1	....	....	1	....	....	....	....	4	4	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Idaho	34	T.	...	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1	T.
		A.	....	...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Illinois	92	T.	....	....	....	....	....	....	....	2	...	....	....	4	22	....	..	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Indiana	58	T.	....	....	....	....	....	....	....	....	....	....	....	1	14	1	..	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3	3	T.
		A.	..	....	....	....	....	....	..	..	....	....	....	....	....	....	....	1	....	....	..	1	....	....	....	....	....	....	....	....	....	....	....	2	2	A.
Indian Territory	11	T.	...	....	....	....	....	....	....	....	....	....	....	....	....	....	...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Iowa	149	T.	....	....	....	....	....	....	....	....	....	....	...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	T.
		A.	...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Kansas	77	T.	1	....	2	1	....	....	1	....	....	....	1	2	1	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	10	8	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Kentucky	41	T.	....	..	.	....	....	...	....	....	....	....	....	....	6	1	..	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	7	2	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Louisiana	46	T.	6	8	1	....	....	....	....	6	4	....	...	3	1	5	....	....	....	....	....	....	....	....	....	....	....	....	4	....	....	....	38	9	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Maine	19	T.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Maryland	48	T.	....	....	....	....	....	....	....	....	....	2	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3	2	T.
		A.	....	....	....	....	..	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Massachusetts	48	T.	....	....	....	..	....	....	..	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.	....	....	....	....	....	....	....	....	....	0	0	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Michigan	106	T.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Minnesota	67	T.	....	...	....	..	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Mississippi	44	T.	5	2	....	....	....	....	....	3	4	....	....	....	9	3	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	27	7	T.
		A.	...	....	....	....	....	....	....	....	....	....	..	13	21	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	36	4	T.
Missouri	95	T.	....	....	1	....	....	....	1	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	2	2	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Montana	40	T.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Nebraska	142	T.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Nevada	40	T.	....	....	....	....	1	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
New Hampshire	19	T.	....	....	....	..	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
New Jersey	51	T.	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	2	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
New Mexico	31	T.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	....	....	....	....	....	2	2	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
New York	99	T.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
North Carolina	56	T.	....	....	4	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	6	1	T.
		A.	...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	0	0	A.
North Dakota	48	T.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Ohio	128	T.	....	....	....	....	....	....	....	....	....	....	....	....	12	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	12	1	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Oklahoma	23	T.	....	1	....	....	....	....	5	..	....	....	....	2	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	10	3	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Oregon	74	T.	....	....	2	1	...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3	3	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Pennsylvania	91	T.	....	...	...	...	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Rhode Island	7	T.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
South Carolina	46	T.	....	....	....	....	....	..	....	....	1	....	....	....	....	1	....	....	....	....	....	....	....	2	....	....	....	....	....	....	....	....	....	4	3	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
South Dakota	56	T.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Tennessee	56	T.	....	....	....	....	....	....	....	2	....	....	....	4	12	....	....	....	....	1	....	....	....	....	....	....	....	....	....	1	....	....	....	19	4	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Texas	95	T.	3	....	....	....	1	.. .	1	10	1	1	...	3	5	1	....	....	....	....	....	....	1	....	....	....	....	1	2	....	1	1	32	14	T.
		A.	...	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Utah	47	T.	....	....	....	1	....	1	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3	3	T.
		A.	....	....	..	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Vermont	16	T.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Virginia	50	T.	...	....	....	....	....	....	....	....	1	1	....	....	....	....	..	....	....	....	....	....	....	1	....	....	....	....	1	....	....	....	....	4	3	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Washington	64	T.	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
West Virginia	43	T.	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	1	1	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Wisconsin	60	T.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	T.
		A.	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Wyoming	31	T.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	T.
		A.	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	0	0	A.
Sums	2,803	T.	21	20	11	3	3	2	9	32	15	4	2	34	112	35	2	0	0	0	0	0	2	1	2	3	0	0	3	4	13	1	1	1	336	....	T.
		A.	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	1	0	1	1	1	0	0	0	0	0	0	0	0	6	....	A.

TABLE V.—*Accumulated amounts of precipitation for each 5 minutes, for storms in which the rate of fall equaled or exceeded 0.25 in any 5 minutes, or 0.75 in 1 hour during December, 1901, at all stations furnished with self-registering gages.*

Stations.	Date.	Total duration.		Total amt of precipitation.	Excessive rate.		Amount before excessive began.	Depths of precipitation (in inches) during periods of time indicated.												
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
	1	2	3	4	5	6	7														
Albany, N. Y.	14-15			1.81														*			
Alpena, Mich.	13-14			0.82														0.60			
Atlanta, Ga.	28-29			4.81														0.54			
Atlantic City, N. J.	10			1.17														*			
Baltimore, Md.	28-30			3.29														*			
Binghamton, N. Y.	14-15	3.30 p. m.	D. N.	2.31	6.00 p. m.	6.45 p. m.	0.04	0.08	0.25	0.35	0.42	0.50	0.58	0.63	0.69	0.73	0.75	0.78			
Bismarck, N. Dak.	6			0.54														*			
Boise, Idaho	1-2			0.66														0.12			
Boston, Mass.	15			1.26														0.40			
Buffalo, N. Y.	14-15			1.94														*			
Cairo, Ill.	13-14			2.67														0.70			
Charleston, S. C.	23			0.46														0.26			
Chicago, Ill.	13			0.81														*			
Cincinnati, Ohio	13-14			1.52														0.29			
Cleveland, Ohio	14-15			1.84														*			
Columbia, Mo.	12-13			0.97														0.19			
Columbus, Ohio	13-14			1.50														*			
Denver, Colo.	11-12			0.46														*			
Des Moines, Iowa	11-12			0.30														*			
Detroit, Mich.	13-14			2.07														0.23			
Dodge, Kans.	3			0.02														*			
Duluth, Minn.	5-7			0.36														0.28			
Eastport, Me.	10			0.55														0.56			
Elkins, W. Va.	14-15			2.79														*			
Erie, Pa.	14-15			1.29														*			
Escanaba, Mich.	12-13			0.41														0.51			
Evansville, Ind.	13-14			2.53														0.15			
Fort Worth, Tex.	8			0.50														0.10			
Fresno, Cal.	2			0.10														*			
Galveston, Tex.	12	1.55 a. m.	6.20 a. m.	0.67	5.37 a. m.	5.50 a. m.	0.05	0.49	0.59	0.61								0.73	1.01	1.29	1.52
Do	28	5.20 a. m.	4.00 p. m.	2.25	5.25 a. m.	7.15 a. m.	T.	0.12	0.25	0.31	0.33	0.37	0.44	0.46	0.48	0.54	0.59	*			
Grand Junction, Colo.	11-12			0.19														0.33			
Harrisburg, Pa.	14-15			1.19														*			
Hatteras, N. C.	3	4.15 a. m.	1.40 p. m.	2.24	6.15 a. m.	7.15 a. m.	0.21	0.05	0.10	0.16	0.24	0.28	0.32	0.39	0.47	0.53	0.68	0.91	1.05		
					11.00 a. m.	11.25 a. m.	1.54	0.05	0.18	0.30	0.40	0.45									
Huron, S. Dak.	18			0.18														*			
Indianapolis, Ind.	13-14			2.36														0.43			
Jacksonville, Fla.	2			1.12														0.45			
Jupiter, Fla.	2	9.30 a. m.	2.50 p. m.	2.34	12.50 p. m.	1.15 p. m.	0.53	0.09	0.41	0.79	1.18	1.42	1.44	1.45	1.48	1.51					
Kalispell, Mont.	22			0.31														*			
Kansas City, Mo.	12-13			1.12														0.23			
Key West, Fla.	11-11			1.31														0.57			
Knoxville, Tenn.	13	3.25 a. m.	4.15 p. m.	3.43	6.05 a. m.	7.15 a. m.	0.53	0.12	0.20	0.25	0.34	0.48	0.52	0.56	0.60	0.69	0.79	0.89	1.11		
Lexington, Ky.	14			1.49														0.34			
Lincoln, Nebr.	18			0.20														*			
Little Rock, Ark.	13	10.00 a. m.	4.55 p. m.	2.23	1.10 p. m.	2.08 p. m.	0.64	0.13	0.39	0.44	0.50	0.63	0.69	0.71	0.82	0.85	0.87	1.19			
Los Angeles, Cal.†																		0.53			
Louisville, Ky.	13-14			2.21														*			
Macon, Ga.	14	10.10 a. m.	8.45 p. m.	2.22	2.15 p. m.	2.40 p. m.	0.46	0.08	0.24	0.42	0.57	0.71									
Memphis, Tenn.	13-14	5.21 p. m.	10.22 a. m.	2.05	6.05 p. m.	6.25 p. m.	0.10	0.09	0.29	0.57	0.73	0.75									
Meridian, Miss.	13-14			1.47														0.72			
Milwaukee, Wis.	12-13			1.30														0.19			
Montgomery, Ala.	14	4.30 a. m.	11.42 a. m.	1.47	8.30 a. m.	9.25 a. m.	0.07	0.11	0.17	0.22	0.24	0.31	0.38	0.59	0.90	1.11	1.25	1.33			
Nantucket, Mass.	10			0.47														0.37			
Nashville, Tenn.	13-14	9.21 p. m.	5.35 p. m.	2.09	10.05 p. m.	11.50 p. m.	0.29	0.05	0.11	0.17	0.25	0.35	0.44	0.74	0.86	0.94	0.97	1.00			
New Haven, Conn.	14-15			1.69														0.70			
New Orleans, La.	28-29			3.06														0.82			
New York, N. Y.	28-30			2.49														0.26			
Norfolk, Va.	29-30			0.76														0.33			
Northfield, Vt.	29			1.00														*			
Oklahoma, Okla.	12-13			0.73														0.23			
Omaha, Nebr.	18			0.29														0.10			
Parkersburg, W. Va.	14-15			1.52														0.22			
Philadelphia, Pa.	28-30			3.28														0.37			
Pittsburg, Pa.	14-15			2.49														*			
Pocatello, Idaho	3-4			0.57														*			
Portland, Me.	10			1.02														0.39			
Portland, Oreg.	7-8			0.79														0.31			
Pueblo, Colo.	11-12			0.20														*			
Raleigh, N. C.	28-29			1.32														0.30			
Richmond, Va.	14-15			1.50														0.60			
Rochester, N. Y.	14-15			2.30														*			
St. Louis, Mo.	13			2.40														0.41			
St. Paul, Minn.	2			0.09														0.06			
Salt Lake City, Utah	9-10			0.26														*			
San Diego, Cal.	6			0.01														*			
Sandusky, Ohio	13-14			1.44														*			
San Francisco, Cal.	2			0.34														0.18			
Savannah, Ga.	2-3			0.30														0.21			
Seattle, Wash.	7			0.43														*			
Spokane, Wash.	1			0.23														0.19			
Springfield, Ill.	13			1.46														0.27			
Tampa, Fla.	29			0.45														0.32			
Toledo, Ohio	13-14			2.05														*			
Topeka, Kans.	12-13			0.35														*			
Valentine, Nebr.	9-10			0.37														0.99			
Vicksburg, Miss.	1-2	5.00 p. m.	D. N.	1.35	8.20 p. m.	9.05 p. m.	0.19	0.15	0.26	0.34	0.39	0.49	0.63	0.75	0.85	0.90	0.93				
Do	8-9	6.10 p. m.	7.25 a. m.	1.87	7.10 p. m.	7.47 p. m.	0.16	0.07	0.14	0.26	0.37	0.44	0.56	0.79	0.84	0.87		0.43			
Washington, D. C.	3			1.83														0.56			
Wilmington, N. C.	2-3			2.17																	
Basseterre, St. Kitts	10-11			0.61														0.23			
Bridgetown, Barbados	1			0.78														0.36			
Cienfuegos, Cuba	2	5.47 p. m.	9.25 p. m.	1.04	6.40 p. m.	7.05 p. m.	0.08	0.31	0.58	0.78	0.81	0.86	0.89					0.41			
Havana Cuba	29			0.64														0.22			
Kingston, Jamaica	29-30			0.36																	
Port of Spain, Trin.	31	9.34 a. m.	4.02 p. m.	1.53	1.41 p. m.	2.00 p. m.	0.89	0.21	0.39	0.51	0.54	0.56	0.59								

TABLE V.—*Accumulated amounts of precipitation for each 5 minutes, etc.*—Continued.

Stations.	Date.	Total duration. From—	Total duration. To—	Total am't of precipitation.	Excessive rate. Began—	Excessive rate. Ended—	Amount before excessive began.	Depths of precipitation (in inches) during periods of time as indicated. 5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
	1	2	3	4	5	6	7														
Puerto Principe, Cuba	29-30	.....	.....	0.32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.19	.....	.....	.....
Roseau, Dominica ...	27	.....	.....	0.57	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.38	.....	.....	.....
San Juan, Porto Rico.	13-14	8.50 p.m.	3.15 a.m.	1.40	10.00 p.m.	10.45 p.m.	0.07	0.04	0.07	0.13	0.18	0.28	0.38	0.48	0.55	0.62	0.62	0.68	0.83	.....	.....
Santiago de Cuba	30	5.18 p.m.	9.25 p.m.	1.41	5.30 p.m.	6.30 p.m.	0.01	0.05	0.11	0.16	0.22	0.23	0.27	0.40	0.55	0.67	0.76	0.85	.....	.....	.....
Santo Domingo, W.I..	27	2.00 p.m.	4.30 p.m.	0.79	2.05 p.m.	2.30 p.m.	T.	0.15	0.35	0.54	0.64	0.69	0.73	0.76	.....	.....	.....	.....	.....	.....	.....
Willemstad, Curaçao .	16	.....	.....	0.42	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.35	.....	.....	.....

*Self-register not working. † No precipitation.

TABLE VI.—*Data furnished by the Canadian Meteorological Service, December*, 1901.

Stations.	Pressure. Mean not reduced.	Pressure. Mean reduced.	Pressure. Departure from normal.	Temperature. Mean.	Temperature. Departure from normal.	Temperature. Mean maximum.	Temperature. Mean minimum.	Precipitation. Total.	Precipitation. Departure from normal.	Precipitation. Depth of snow.
	Ins.	*Ins.*	*Ins.*	°	°	°	°	*Ins.*	*Ins.*	*Ins.*
St. Johns, N. F.....	29.78	29.93	+.08	34.8	+ 6.1	40.2	29.4	5.01	−0.07	9.0
Sydney, C. B. I.....	29.98	30.02	+.14	32.3	+ 4.1	38.8	26.0	8.43	+3.71	36.5
Halifax, N. S.....	29.92	30.03	+.08	33.0	+ 5.4	40.9	25.1	8.56	+3.27	30.9
Grand Manan, N. B...	29.96	30.01	+ 02	30.8	+ 2.5	37.9	23.6	6.80	+2.13	19.8
Yarmouth, N. S.....	29.97	30.05	+.07	33.0	+ 2.3	39.6	26.4	6.43	+1.16	13.9
Charlottet'n, P. E. I...	29.96	30.00	+.08	29.3	+ 5.0	36.0	22.6	5.25	+1.25	19.1
Chatham, N. B.....	29.97	29.99	+.05	20.8	+ 3.8	30.2	11.3	4.13	+1.16	24.1
Father Point, Que....	29.96	29.99	+.03	19.5	+ 4.1	26.8	12.2	4.50	+2.28	43.1
Quebec, Que.....	29.68	30.03	+.02	18.9	+ 3.7	25.3	12.6	3.20	−1.11	23.9
Montreal, Que.....	29.82	30.04	+.01	21.4	+ 3.1	27.4	15.3	4.68	+1.12	15.1
Bissett, Ont.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Ottawa, Ont.....	29.75	30.09	+.06	18.5	+ 1.5	25.6	11.1	4.32	+1.37	21.9
Kingston, Ont	29.71	30.04	−.01	24.7	+ 1.0	31.1	18.2	3.76	+0.12	8.4
Toronto, Ont	29.64	30.04	−.02	26.9	− 0.1	33.2	20.6	3.59	+1.05	13.6
White River, Ont.....	28.63	30.08	+.02	7.8	− 1.9	18.6	− 2.9	1.78	+0.34	17.8
Port Stanley, Ont ...	29.38	30.05	−.01	25.7	− 2.7	32.3	19.0	4.46	+1.85	24.0
Saugeen, Ont.....	29.27	30.02	.00	25.5	− 1.2	32.1	18.9	4.02	−0.11	25.1
Parry Sound, Ont ...	29.28	30.02	−.01	21.1	− 0.1	29.4	12.7	5.98	+2.05	37.0
Port Arthur, Ont....	29.27	30.02	−.01	12.1	− 1.1	20.4	3.7	0.35	−0.50	3.5
Winnipeg, Man.....	29.16	30.05	−.06	9.4	+ 5.3	18 3	0.4	0.43	−0.76	4.3
Minnedosa, Man.....	28.12	30.06	−.05	10.3	+ 4.6	19.2	1.4	0.48	−0.25	4.8
Qu'Appelle, Assin...	27.62	30.02	−.11	11.9	+ 4.5	20.3	3.6	1.51	+0.87	15.1
Medicine Hat, Assin.	27.63	30.02	−.09	27.3	+ 9.1	36.5	18.0	0.30	−0.06	2.0
Swift Current, Assin.	27.34	30.05	−.08	19.5	+ 3.5	27.6	11.4	0.50	−0.21	4.7
Calgary, Alberta	26.30	29.96	−.17	26.3	+ 8.1	35.3	17.2	1.85	+1.07	18.5
Banff, Alberta	25.28	30.07	.....	23.6	+ 4.5	30.1	17.2	0.92	−0.33	9.2
Edmonton, Alberta .	27.54	29.93	−.08	23.1	+10.0	31.1	15.2	1.04	+0.64	9.8
Prince Albert, Sask..	28.33	29.98	−.11	10.3	+ 7.5	19.2	1.4	0.34	−0.36	3.4
Battleford, Sask.....	28.18	30.03	−.07	14.6	+ 9.2	22.0	7.2	0.57	+0.26	5.7
Kamloops, B. C	28.84	30.16	+.14	31.2	+ 2.3	36.3	26.2	0.46	−0.54	T.
Victoria, B. C	30.08	30.18	+.23	43.0	+ 1.8	46.1	39.9	3.46	−4.30	0.0
Barkerville, N. W. T.	25.58	30.02	.....	24.1	+ 3.2	29.5	18.7	4.20	+0.60	42.0
Hamilton, Bermuda.	29.98	30.14	+.05	64.4	− 0.3	68.6	60.2	3.33	−0.98	0.0

TABLE VII.—*Heights of rivers referred to zeros of gages, December, 1901.*

Stations.	Distance to mouth of river.	Danger line on gage.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
Mississippi River.	*Miles.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
St. Paul, Minn[1]	1,954	14	.....	.....	.....	.....	.....	.....
Reeds Landing, Minn	1,884	12	0.8	1	−0.4	31	0.2	1.2
La Crosse, Wis	1,819	12	2.9	25-27	0.3	15	2.1	2.6
Prairie du Chien, Wis[2]	1,759	18	.....	.....	.....	.....	.....	.....
Dubuque, Iowa[3]	1,699	15	2.5	1-3	1.8	8,9	.....	0.7
Leclaire, Iowa[4]	1,609	10	1.1	1,2	0.5	12	.....	0.6
Davenport, Iowa[5]	1,593	15	2.7	15	1.5	10	2.0	1.2
Muscatine, Iowa	1,562	16	3.3	31	1.9	19,20	2.4	1.4
Galland, Iowa[6]	1,472	8	1.0	1-3	0.6	9-14,17	0.8	0.4
Keokuk, Iowa[8]	1,463	15	1.8	17	−1.5	16	0.4	3.3
Hannibal, Mo[9]	1,402	13	1.8	1-3	−0.2	15	1.4	2.0
Grafton, Ill	1,306	23	3.5	1,2	1.4	17,18	2.6	2.1
St. Louis, Mo[7]	1,264	30	7.5	27	−1.3	19	3.2	8.8
Chester, Ill[8]	1,189	36	2.0	25,26	−0.3	21	1.2	2.3
New Madrid, Mo	1,003	34	22.5	24	3.5	1	11.7	19.0
Memphis, Tenn	843	33	18.2	26	−0.2	1,2	6.8	18.4
Helena, Ark	767	42	24.6	28	1.4	2	10.1	23.2
Arkansas City, Ark	635	42	24.5	29	1.0	1-4	9.1	23.5
Greenville, Miss	595	42	20.0	29	0.8	4	7.2	19.2
Vicksburg, Miss	474	45	21.6	31	−2.3	5-7	4.9	23.9
New Orleans, La	108	16	6.0	30	2.9	1,6,7,11	3.5	3.1
Missouri River.								
Bismarck, N. Dak	1,309	14	4.1	14	1.4	8,9,31	2.3	2.7
Pierre, S. Dak[4]	1,114	14	2.1	3	0.7	8	.....	1.4
Sioux City, Iowa[9]	784	19	.....	.....	.....	.....	.....	.....
Omaha, Nebr[4]	669	18	4.7	5-7	3.5	13	.....	1.2
St. Joseph, Mo	481	10	0.6	1	−1.2	18	−0.2	1.8
Kansas City, Mo	388	21	6.5	7	3.7	18	5.2	2.8
Boonville, Mo	199	20	5.8	30,31	5.1	22,23	5.4	0.7
Hermann, Mo[10]	103	24	3.4	14,19	0.8	18	2.9	2.6
Illinois River.								
Peoria, Ill	135	14	7.7	25-28	6.4	1-12	6.9	1.3
Youghiogheny River.								
Confluence, Pa	59	10	10.6	15	1.8	9	3.7	8.8
West Newton, Pa[11]	15	23	13.3	15	0.7	1	3.9	12.6
Allegheny River.								
Warren, Pa	177	14	10.9	15	1.9	9	4.2	9.0
Oil City, Pa	123	13	11.4	15	2.5	9	4.9	8.9
Parker, Pa	73	30	13.4	15	2.8	9	5.5	10.6
Monongahela River.								
Weston, W. Va	161	18	12.9	15	0.0	{1,2,6-9, 13,14, 19-24}	1.7	12.9
Fairmont, W. Va	119	25	18.5	15	1.4	1-3	5.3	17.1
Greensboro, Pa[12]	81	18	24.0	15	7.0	2	10.4	17.0
Lock No. 4, Pa	40	28	28.5	16	7.1	2	11.8	21.4
Conemaugh River.								
Johnstown, Pa	64	7	10.8	15	1.6	1,2	3.3	9.2
Red Bank Creek.								
Brookville, Pa	35	8	4.0	15	1.2	29-31	1.8	2.8
Beaver River.								
Ellwood Junction, Pa[10]	10	14	4.9	16,17	3.0	7-10	3.7	1.9
Great Kanawha River.								
Charleston, W. Va	58	30	38.5	30	4.6	25	10.9	33.9
Little Kanawha River.								
Glenville, W. Va	103	20	19.0	15	0.5	22	3.5	18.5
New River.								
Hinton, W. Va	95	14	17.4	30	1.7	1-3	4.4	15.7
Cheat River.								
Rowlesburg, W. Va[13]	36	14	12.6	15	2.2	1,2	4.9	10.4
Ohio River.								
Pittsburg, Pa	966	22	25.8	16	3.9	24	9.0	21.9
Davis Island Dam, Pa	960	25	24.3	16	5.9	24	9.9	18.4
Wheeling, W. Va	875	36	33.9	17	7.2	3	13.2	26.7
Parkersburg, W. Va	785	36	28.8	18	8.0	3-5,10,11	12.9	20.8
Point Pleasant, W. Va	703	39	39.4	31	6.6	4	16.3	32.8
Huntington, W. Va	660	50	42.8	31	9.9	4,5	19.8	32.9
Catlettsburg, Ky	651	50	43.5	31	8.6	5	19.8	34.9
Portsmouth, Ohio	612	50	40.5	31	9.5	5	20.0	31.0
Cincinnati, Ohio	499	50	39.5	20	10.7	7	20.6	28.8
Madison, Ind	413	46	32.0	20	9.8	8	17.5	22.2
Louisville, Ky	367	28	13.4	20	5.2	1	8.6	8.2
Evansville, Ind	184	35	28.7	22	4.0	1,2	14.4	24.7
Paducah, Ky	47	40	27.5	23	2.3	1	12.7	25.2
Cairo, Ill	1,073	45	27.6	24	3.5	1	14.0	24.1
Muskingum River.								
Zanesville, Ohio	70	30	14.2	31	6.2	7	9.3	8.0
Scioto River.								
Columbus, Ohio[5]	110	17	2.9	15	1.9	1-8	2.0	1.0
Miami River.								
Dayton, Ohio	77	18	1.9	15	0.1	12	0.8	1.8
Wabash River.								
Mount Carmel, Ill[8]	50	15	8.7	17	0.8	1-8,12,13	2.9	7.9
Licking River.								
Falmouth, Ky[11]	30	25	10.3	16	0.6	5	3.6	9.7
Kentucky River.								
Frankfort, Ky	65	31	17.0	17	6.0	23-25	8.3	11.0
Clinch River.								
Speers Ferry, Va	156	20	21.5	30	−0.5	1	3.8	22.0
Clinton, Tenn	52	25	31.0	31	2.2	2	10.0	28.8
Tennessee River.								
Knoxville, Tenn	635	29	31.0	31	0.9	1-3	6.9	30.1
Kingston, Tenn	556	25	28.8	31	1.5	2,3	7.4	27.3
Chattanooga, Tenn	452	33	39.5	31	2.2	2	10.8	37.3
Bridgeport, Ala	402	24	24.4	31	0.9	2,3	7.8	23.5
Florence, Ala	255	16	16.2	19,20,31	1.0	1,2	6.9	15.2
Riverton, Ala	225	25	24.4	21	0.0	5,6	9.1	24.4
Johnsonville, Tenn	95	24	22.8	22	1.7	8	9.7	21.1

Stations.	Distance to mouth of river.	Danger line on gage.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
Cumberland River.	*Mil s.*	*Feet*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Burnside, Ky	516	50	42.0	15	1.5	3-5	9.8	40.5
Carthage, Tenn	305	40	27.5	18	1.5	4,7	9.9	26.0
Nashville, Tenn	189	40	29.0	19	2.1	1,2	11.7	26.9
Clarksville, Tenn	126	42	31.0	20	2.7	1	13.2	28.3
Arkansas River.								
Wichita, Kans	832	10	1.3	2	1.0	31	1.2	0.3
Webbers Falls, Ind. T.[13]	465	23	2.5	14	1.5	{1-7,23, 28-31}	1.6	1.0
Fort Smith, Ark	403	22	2.9	20,27	0.8	7-9	1.6	2.1
Dardanelle, Ark	256	21	3.2	14	0.3	5-8,11,12	1.2	2.9
Little Rock, Ark[14]	176	23	7.9	16	1.4	1,7,8	3.1	6.5
White River.								
Newport, Ark	150	26	4.5	16	0.1	1-8	1.6	4.4
Yazoo River.								
Yazoo City, Miss	80	25	11.6	29	−0.8	8	5.8	12.4
Red River.								
Arthur City, Tex	638	37	4.4	19	2.8	31	3.5	1.6
Fulton, Ark	515	28	11.0	17	3.0	3	5.8	8.0
Shreveport, La	327	29	6.1	20	−0.8	1	1.7	6.9
Alexandria, La	118	33	4.0	25	−2.7	2	0.1	6.7
Ouachita River.								
Camden, Ark	304	39	27.5	18,19	4.4	3-8	12.6	23.1
Monroe, La	122	40	15.4	29	3.0	7,8	9.5	12.4
Atchafalaya River.								
Melville, La	100	31	20.8	31	3.0	1	8.3	17.8
Susquehanna River.								
Wilkesbarre, Pa	183	14	24.0	15	2.1	1	8.1	21.9
Harrisburg, Pa	69	17	21.4	16	2.2	8,9	5.9	19.2
W. Br. of Susquehanna.								
Williamsport, Pa	39	20	20.7	15	1.8	7-9	5.1	18.9
Juniata River.								
Huntingdon, Pa[16]	90	24	14.0	15	3.0	1-9	4.8	11.0
Potomac River.								
Cumberland, Md	290	8	11.0	15	2.4	2	4.2	8.6
Harpers Ferry, W. Va	172	16	18.3	16	0.5	2,3	4.8	17.8
James River.								
Lynchburg, Va	260	18	21.2	30	0.3	1,2	3.8	20.9
Richmond, Va	111	12	23.2	31	0.3	8	3.4	22.9
Roanoke River.								
Weldon, N. C	129	30	34.5	31	8.8	1-3	13.1	25.7
Cape Fear River.								
Fayetteville, N. C	112	38	35.5	31	3.6	3	7.9	31.9
Edisto River.								
Edisto, S. C	75	6	2.5	30,31	1.9	11-15	2.2	0.6
Pedee River.								
Cheraw, S. C	149	27	33.3	31	2.5	3	7.3	30.8
Black River.								
Kingstree, S. C	52	12	5.0	31	2.5	1,2,11-15	3.1	2.5
Lynch Creek.								
Effingham, S. C	35	12	7.5	31	4.0	6-9,13,14	5.0	3.5
Santee River.								
St. Stephens, S. C	97	12	8.7	27,28	4.0	4-6	6.2	4.7
Congaree River.								
Columbia, S. C	37	15	21.6	31	0.9	3-5,8	3.5	20.7
Wateree River.								
Camden, S. C	45	24	30.5	31	3.3	10	9.2	27.2
Waccamaw River.								
Conway, S. C	40	7	3.9	30	1.1	11	2.4	2.8
Savannah River.								
Calhoun Falls, S. C	347	15	17.9	30	2.1	1,2	4.4	15.8
Augusta, Ga	268	32	31.0	31	8.2	3,4	11.5	22.8
Broad River.								
Carlton, Ga	30	11	19.9	30	2.5	1,2	4.2	17.4
Flint River.								
Albany, Ga	80	20	9.1	25,26	2.9	14,15	5.6	6.2
Chattahoochee River.								
Westpoint, Ga	239	20	25.0	30	2.4	2	5.3	22.6
Ocmulgee River.								
Macon, Ga	125	18	17.9	31	1.9	1,2,4	4.9	16.0
Oconee River.								
Dublin, Ga	79	30	8.6	31	1.0	1-3	3.5	7.6
Coosa River.								
Rome, Ga	271	30	32.6	31	1.3	1-3	7.1	31.3
Gadsden, Ala	144	18	22.0	31	0.1	1-3	6.6	21.9
Alabama River.								
Montgomery, Ala	265	35	44.4	31	1.6	2	8.9	42.8
Selma, Ala	212	35	35.0	31	1.8	1,2	9.3	33.2
Tombigbee River.								
Columbus, Miss	303	33	11.0	30	−2.3	3,4	2.8	13.3
Demopolis, Ala	155	35	35.2	31	0.7	2	13.9	34.5
Black Warrior River.								
Tuscaloosa, Ala	129	43	49.0	30,31	1.3	5	13.6	47.7
Brazos River.								
Kopperl, Tex	369	21	−0.4	1	−1.6	12-31	−1.3	1.2
Waco, Tex	301	22	1.1	1,2	1.0	3-31	1.0	0.1
Booth, Tex	76	39	0.2	18	−0.2	25	0.0	0.4
Red River of the North.								
Moorhead, Minn[15]	418	26	.....	.....	.....	.....	.....	.....
Columbia River.								
Umatilla, Oreg	270	25	3.5	26	−3.3	1	0.6	6.8
The Dalles, Oreg	166	40	5.6	28	1.9	20-22	3.5	3.7
Willamette River.								
Albany, Oreg	118	20	18.4	11	3.9	23	7.9	14.5
Portland, Oreg	12	15	9.8	11	1.9	20	6.0	7.9
Sacramento River.								
Red Bluff, Cal	265	23	17.5	4	1.1	26-31	4.2	16.4
Sacramento, Cal	64	29	20.5	4	11.6	31	15.4	8.9

[1] Frozen for 28 days. [2] Frozen for 25 days. [3] Frozen for 17 days. [4] Frozen for 18 days. [5] Frozen for 16 days. [6] Frozen for 14 days. [7] Frozen for 3 days. [8] Frozen for 2 days. [9] Frozen for 23 days. [10] Frozen for 12 days. [11] Frozen for 5 days. [12] Frozen for 1 day. [13] Frozen for 6 days. [14] Frozen for 4 days. [15] Frozen for 29 days. [16] Frozen for 24 days.

Chart I. Tracks of Centers of High Areas. December, 1901.

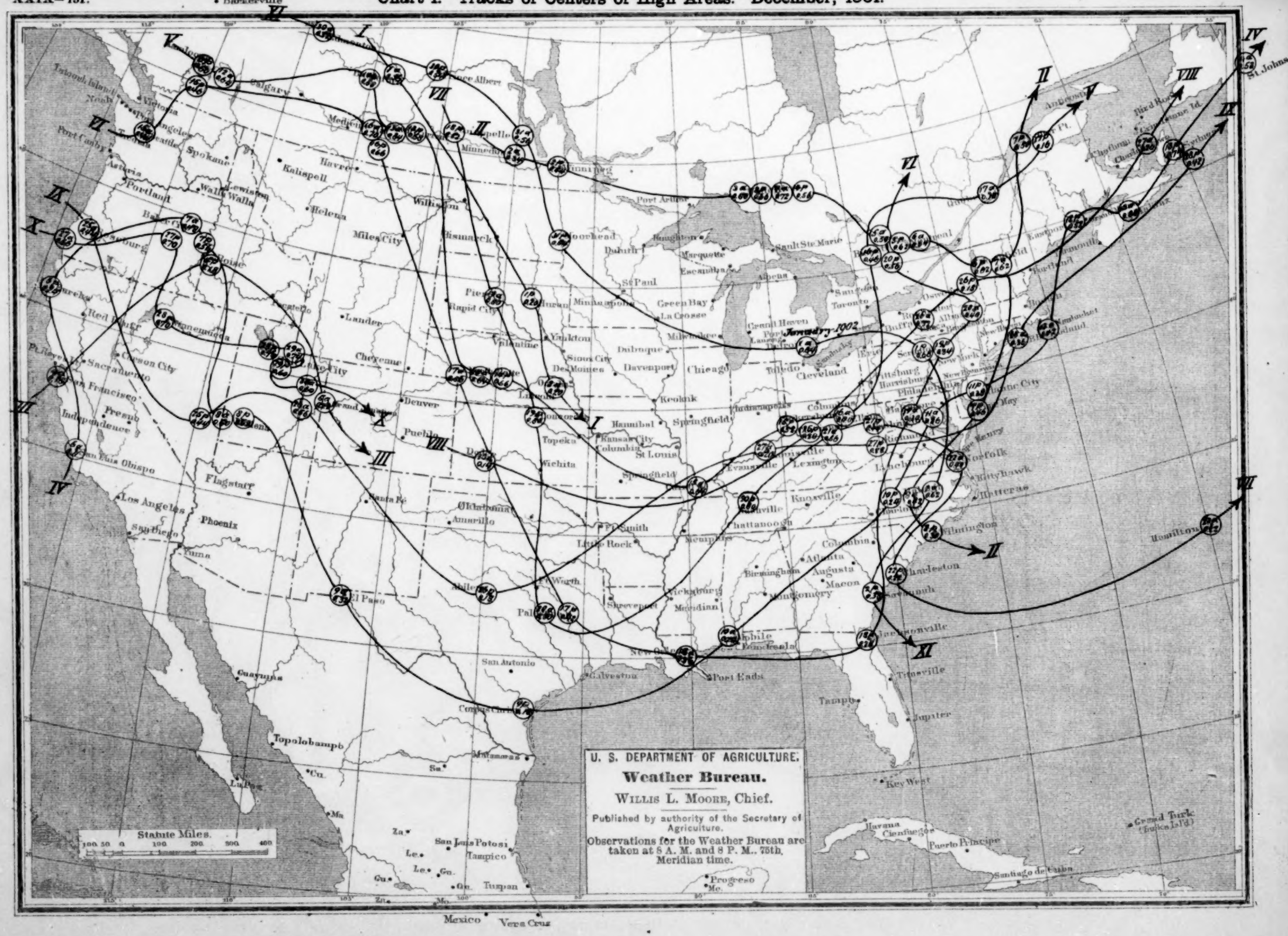
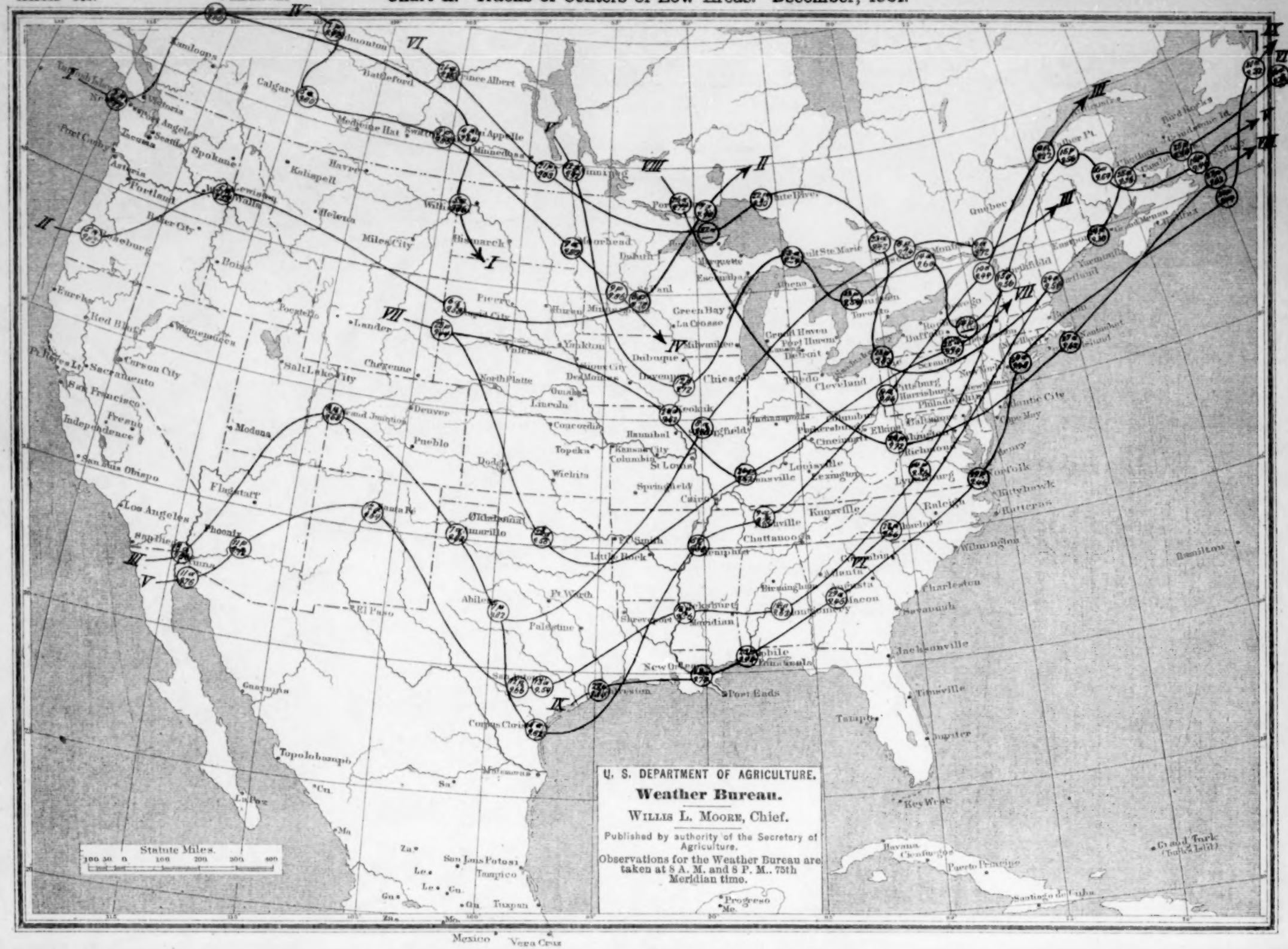


Chart II. Tracks of Centers of Low Areas. December, 1901.



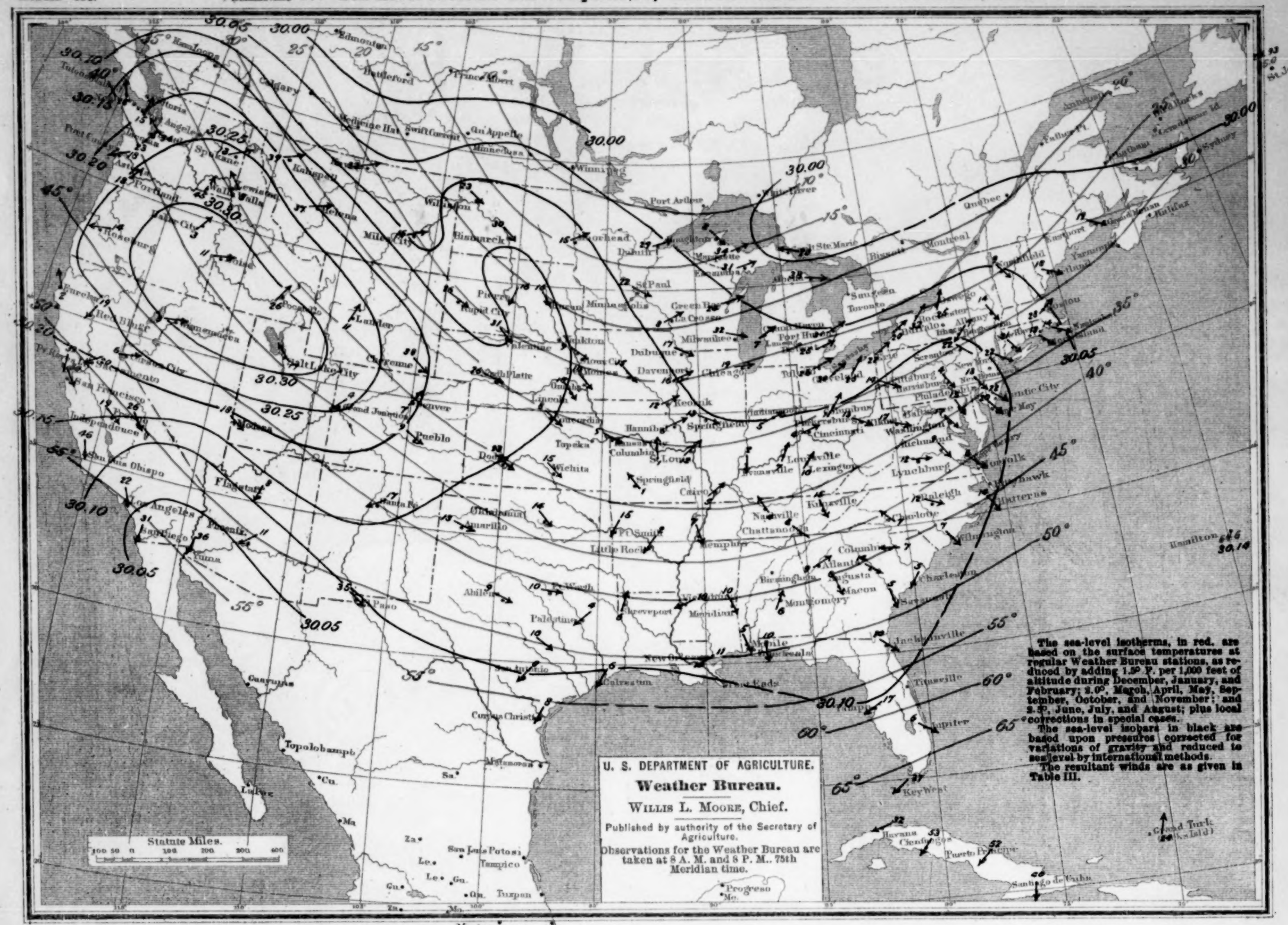
XXIX—133.

Chart III. Total Precipitation. December, 1901.

Chart III. Total Precipitation. December, 1901.

Scale of Shades.
0 to 2 inches.
2 " 4 "
4 " 6 "
6 " 8 "
Over 8 "
Statute Miles.
100 50 0 100 200 300 400
U. S. DEPARTMENT OF AGRICULTURE.
Weather Bureau.
WILLIS L. MOORE, Chief.
Published by authority of the Secretary of Agriculture.
Observations for the Weather Bureau are taken at 8 A. M. and 8 P. M., 75th Meridian time.
Mexico
Vera Cruz

Chart IV. Sea-Level Pressure and Temperature; Resultant Surface Winds. December, 1901.



U. S. DEPARTMENT OF AGRICULTURE.

Weather Bureau.

WILLIS L. MOORE, Chief.

Published by authority of the Secretary of Agriculture.

Observations for the Weather Bureau are taken at 8 A. M. and 8 P. M., 75th Meridian time.

The sea-level isotherms, in red, are based on the surface temperatures at regular Weather Bureau stations, as reduced by adding 1.5° F. per 1,000 feet of altitude during December, January, and February; 2.0°, March, April, May, September, October, and November; and 2.5°, June, July, and August; plus local corrections in special cases.

The sea-level isobars in black are based upon pressures corrected for variations of gravity and reduced to sea level by international methods.

The resultant winds are as given in Table III.

 Chart V. Hydrographs for Seven Principal Rivers of the United States. December, 1901.

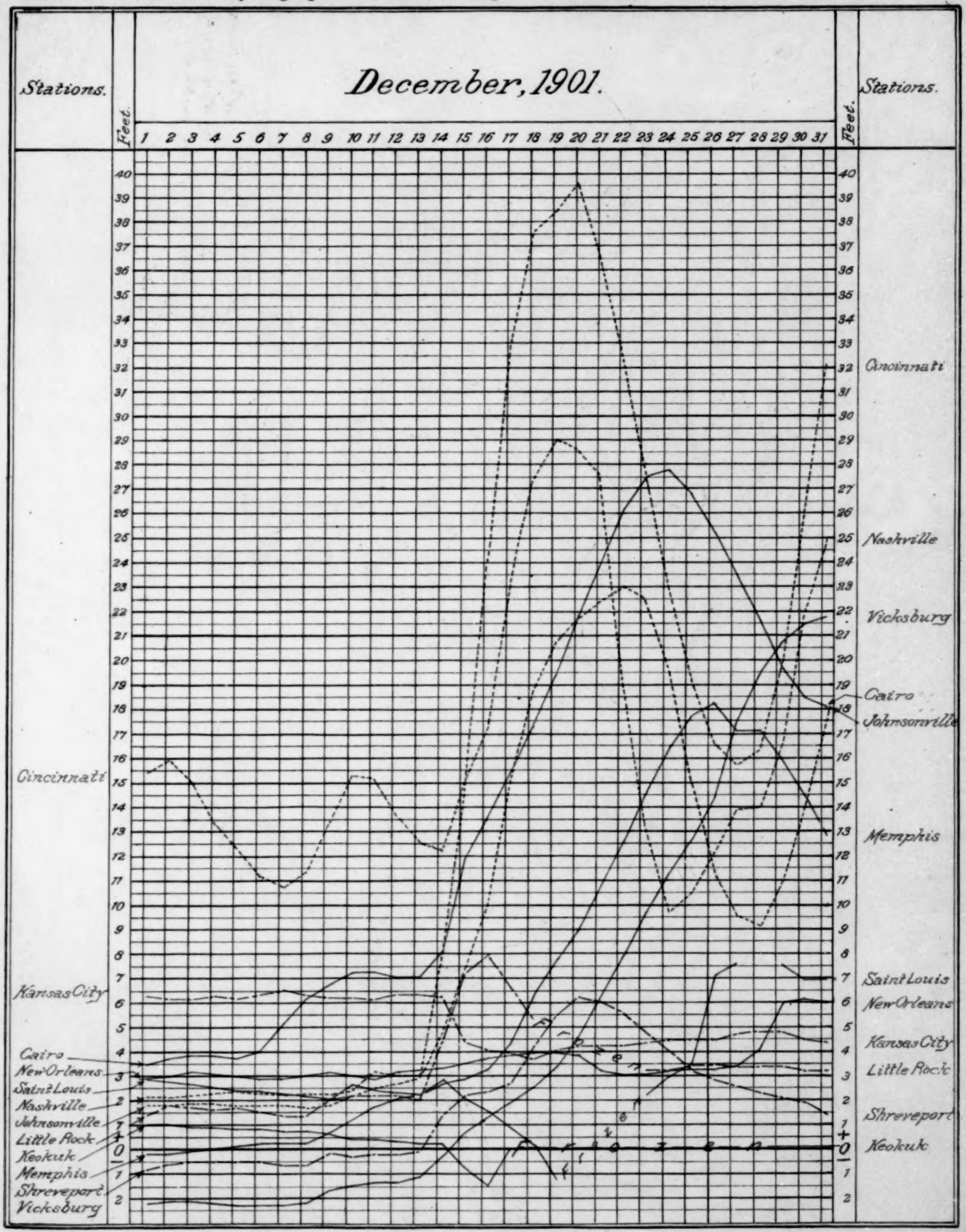


Chart VI. Surface Temperatures; Maximum, Minimum, and Mean. December, 1901.

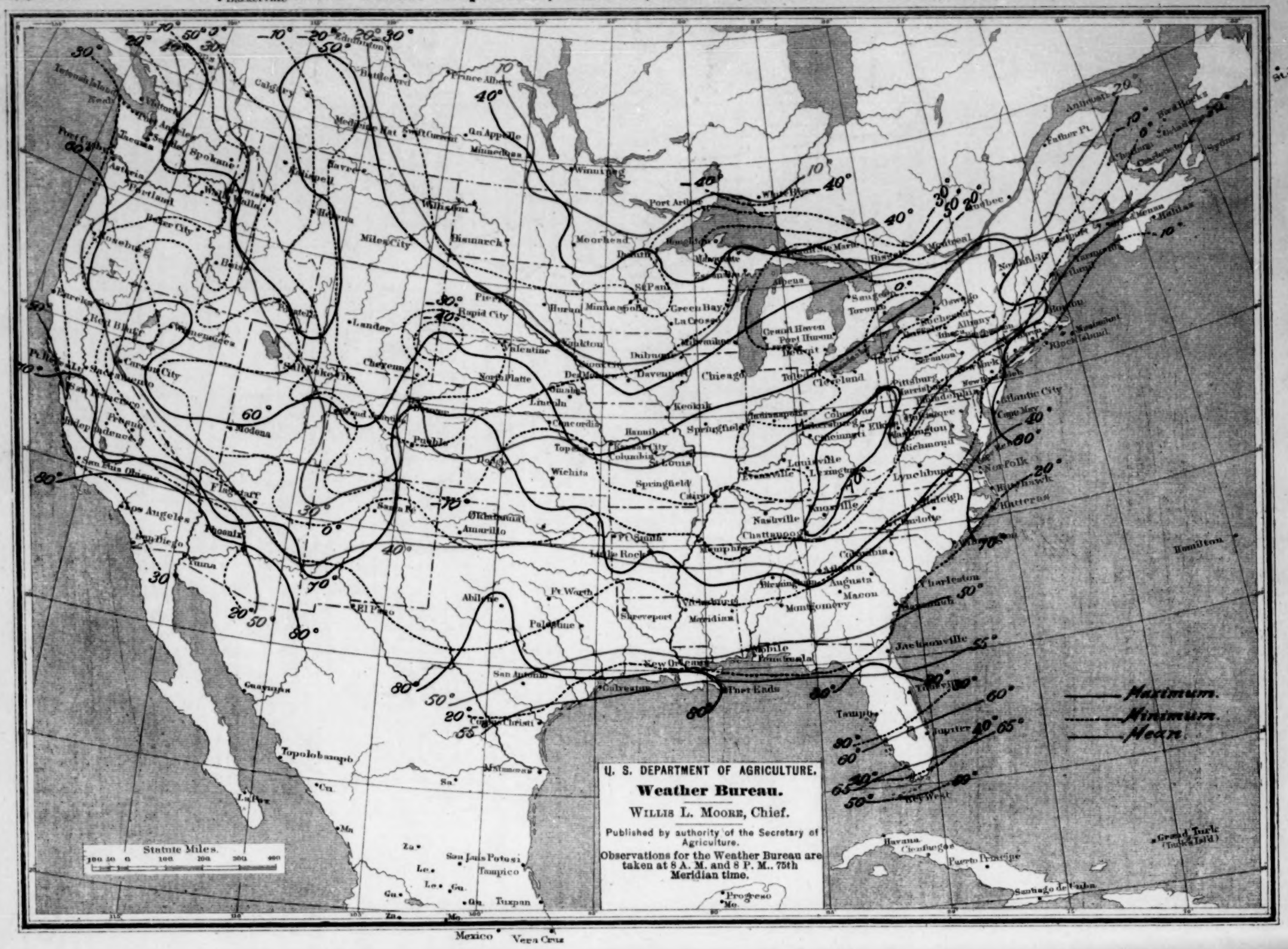

Maximum.
Minimum.
Mean.
Statute Miles.
U. S. DEPARTMENT OF AGRICULTURE.
Weather Bureau.
Willis L. Moore, Chief.
Published by authority of the Secretary of Agriculture.
Observations for the Weather Bureau are taken at 8 A. M. and 8 P. M., 75th Meridian time.

Chart VII. Percentage of Sunshine. December, 1901.

Chart VII. Percentage of Sunshine. December, 1901.

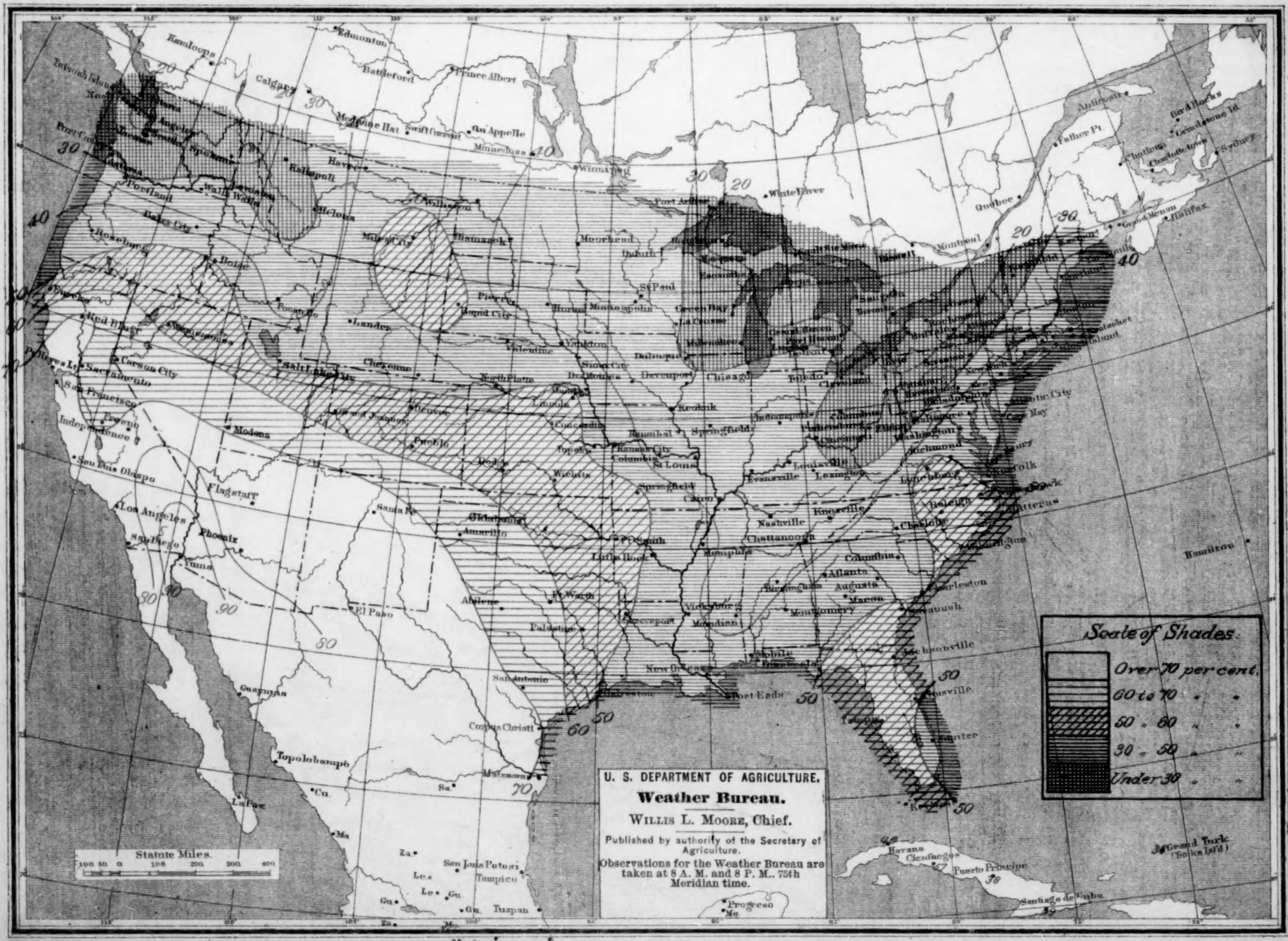
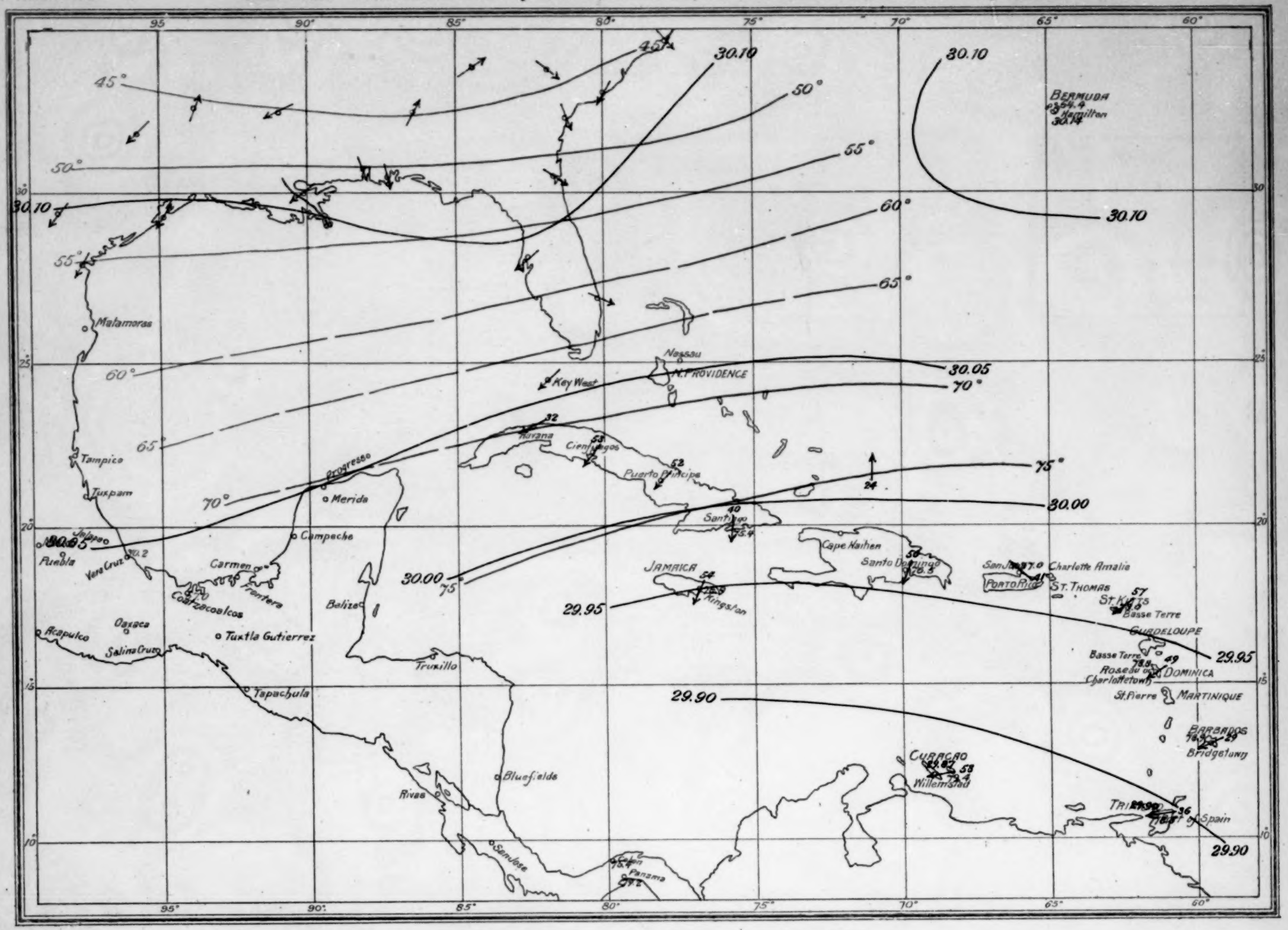


Chart VIII. West Indian Monthly Isobars, Isotherms, and Resultant Winds. December, 1901.



XXIX—139.

Chart IX. Total Snowfall for December, 1901.

† Barkerville

Chart IX. Total Snowfall for December, 1901.

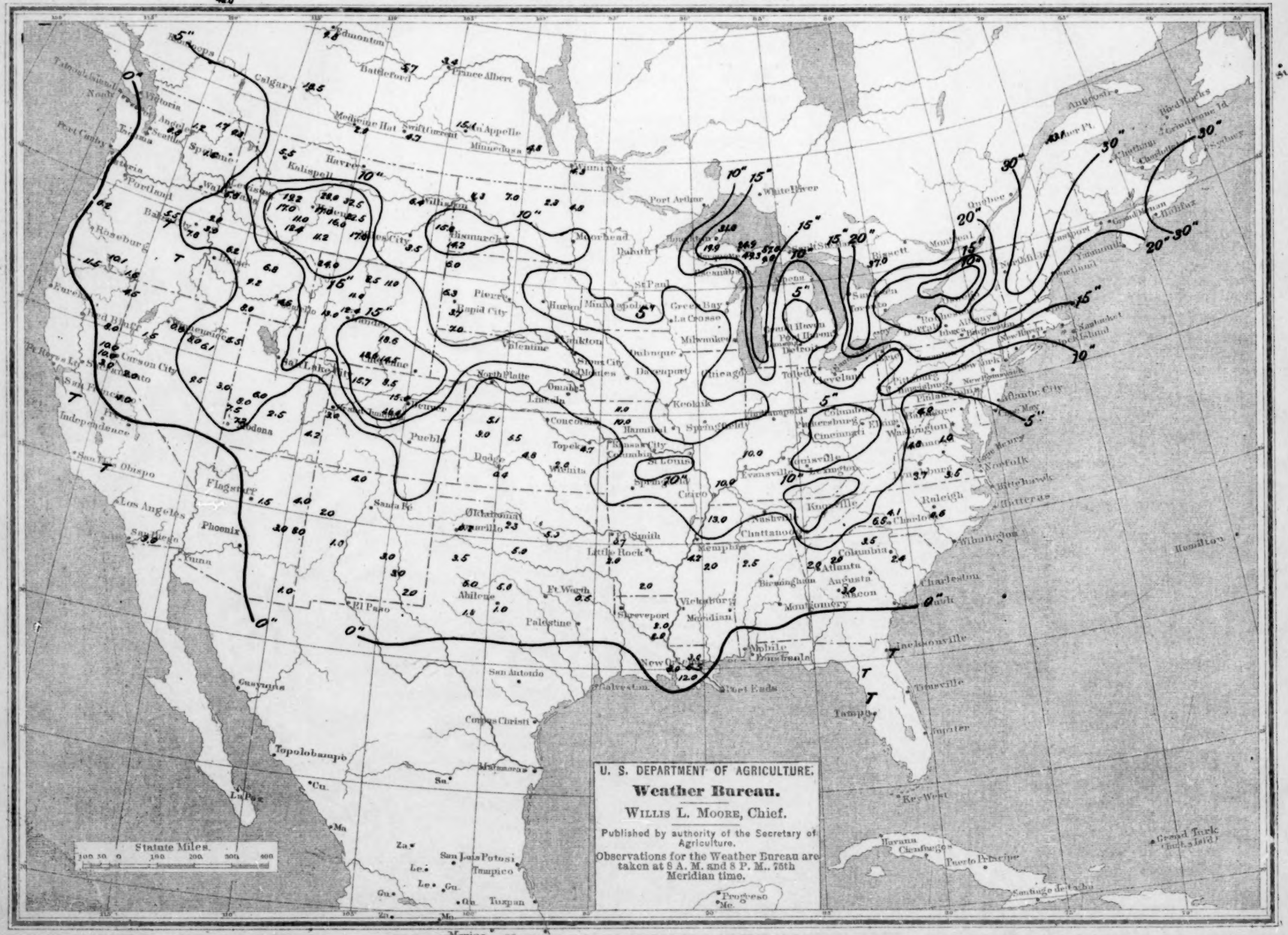
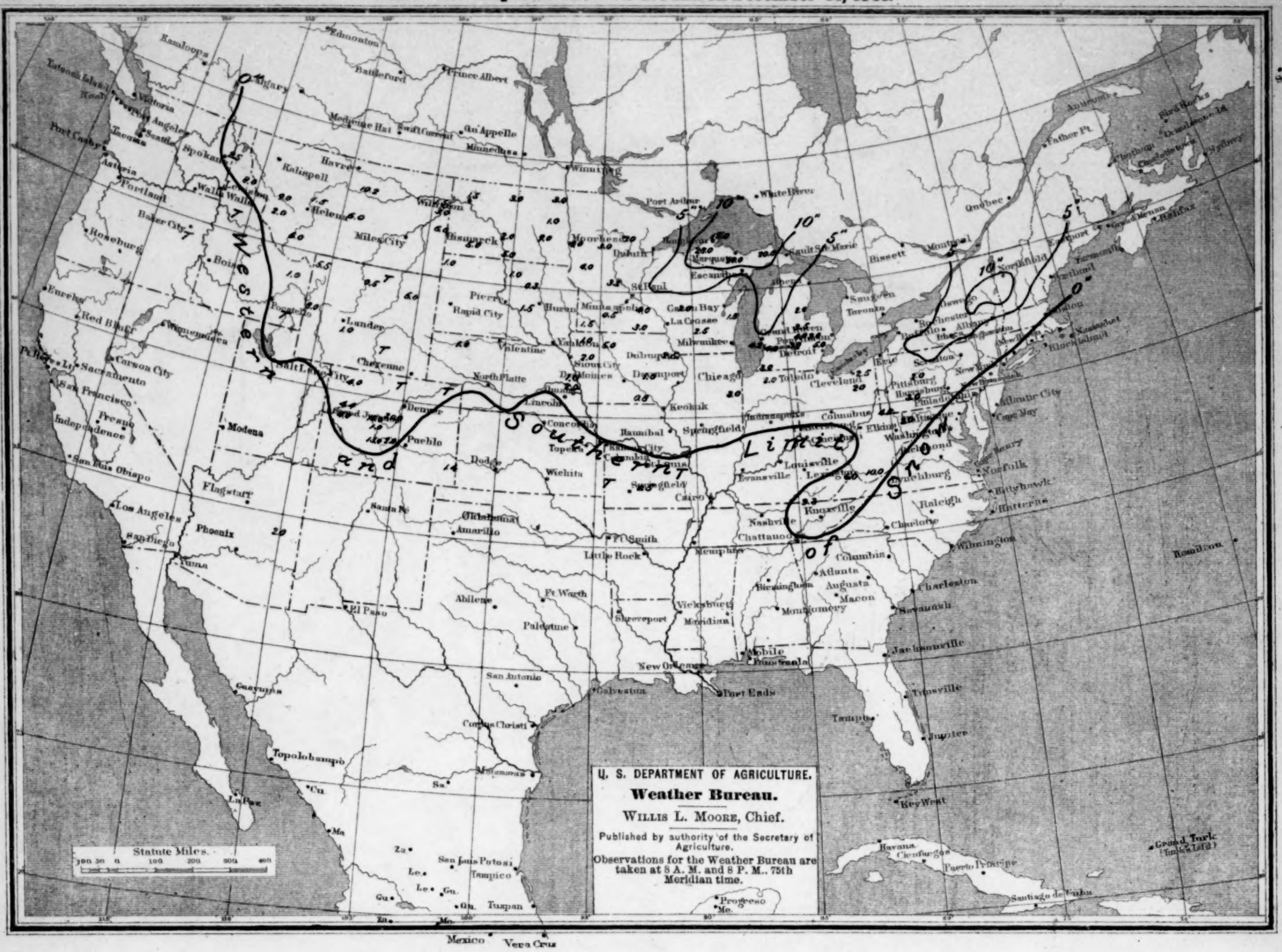


Chart X. Depth of Snow on Ground on December 31, 1901.


Statute Miles.
100 50 0 100 200 300 400
U. S. DEPARTMENT OF AGRICULTURE.
Weather Bureau.
WILLIS L. MOORE, Chief.
Published by authority of the Secretary of Agriculture.
Observations for the Weather Bureau are taken at 8 A. M. and 8 P. M., 75th Meridian time.
Western and Southern Limit of 5" Snow
10"
5"
Barkerville
St. Johns
Edmonton
Battleford
Prince Albert
Kamloops
Victoria
Port Angeles
Seattle
Tacoma
Spokane
Portland
Walla Walla
Baker City
Roseburg
Eureka
Red Bluff
Carson City
Sacramento
San Francisco
Fresno
Independence
Modena
San Luis Obispo
Los Angeles
San Diego
Flagstaff
Phoenix
Yuma
Santa Fe
Oklahoma
Amarillo
El Paso
Abilene
Ft Worth
Paleotine
Abilene
Fort Smith
Little Rock
Memphis
Shreveport
Vicksburg
Meridian
Mobile
New Orleans
San Antonio
Galveston
Port Eads
Corpus Christi
Guaymas
Topolobampo
La Paz
Mazatlan
San Luis Potosi
Tampico
Tuxpan
Mexico
Vera Cruz
Havre
Medicine Hat
Swift Current
Qu'Appelle
Minnedosa
Winnipeg
Ralispell
Helena
Miles City
Bismarck
Moorhead
Duluth
Pierre
Rapid City
Huron
Minneapolis
Valentine
Yankton
Sioux City
Dubuque
Lander
Cheyenne
North Platte
Des Moines
Davenport
Chicago
Lincoln
Omaha
Keokuk
Denver
Concordia
Rantoul
Springfield
Topeka
Kansas City
Columbia
Wichita
Dodge
Springfield
Cairo
Santa Fe
Oklahoma
Amarillo
Abilene
Ft Worth
Paleotine
Shreveport
Vicksburg
Meridian
Little Rock
Memphis
Nashville
Chattanooga
Knoxville
Louisville
Evansville
Lexington
Cincinnati
Indianapolis
Columbus
Springfield
Toledo
Cleveland
Detroit
Erie
Buffalo
Rochester
Albany
Syracuse
Toronto
Saugeen
Owen Sound
Collingwood
Port Arthur
White River
Sault Ste Marie
Marquette
Escanaba
Bissett
Montreal
Quebec
Father Pt
Father Point
Rimouski
Chatham
Campbellton
Dalhousie
Grand Manan
Halifax
Yarmouth
Antigonish
Pictou
Charlottetown
Sydney
Bird Rocks
Grand Manan
Portland
Boston
Worcester
Concord
Manchester
Nashua
Lowell
Lawrence
Haverhill
Gloucester
Salem
Lynn
Fall River
New Bedford
Providence
Hartford
New Haven
Bridgeport
Stamford
New York
Brooklyn
Jersey City
Newark
Trenton
Philadelphia
Pittsburg
Harrisburg
Reading
Scranton
Wilkesbarre
Williamsport
Elmira
Binghamton
Utica
Rochester
Oswego
Ogdensburg
Watertown
Plattsburg
Burlington
Rutland
Montpelier
Northfield
Wells River
Newport
Lancaster
Concord
Portsmouth
Dover
Rochester
Berlin
Gorham
Bangor
Portland
Augusta
Lewiston
Waterville
Skowhegan
Dexter
Houlton
Presque Isle
Caribou
Fredericton
St. John
Moncton
Amherst
Pictou
New Glasgow
Truro
Halifax
Yarmouth
Digby
Annapolis
Kentville
Windsor
Wolfville
Middleton
Bridgetown
Liverpool
Shelburne
Lunenburg
Mahone Bay
Bridgewater
Chester
Sydney
Glace Bay
North Sydney
Louisburg
Baddeck
Port Hawkesbury
Antigonish
Pictou
New Glasgow
Truro
Amherst
Moncton
Fredericton
St. John
Woodstock
Grand Falls
Edmundston
Campbellton
Dalhousie
Chatham
Newcastle
Bathurst
Dalhousie
Campbellton
Matapedia
Metapedia
Rimouski
Father Point
Father Pt
Quebec
Montreal
Sherbrooke
Magog
Coaticook
Stanstead
Newport
Barre
Montpelier
Burlington
Rutland
Bennington
Brattleboro
Keene
Nashua
Manchester
Concord
Portsmouth
Dover
Rochester
Berlin
Gorham
Lewiston
Augusta
Waterville
Skowhegan
Dexter
Houlton
Presque Isle
Caribou
Bangor
Portland
Boston
Worcester